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APRIL, 1990
SURVEY
UNIROYAL CHEMICAL LTD.
ELMIRA



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1.0 INTRODUCTION

1.0 Purpose

This is the report of Mr. R. Hillier, a Provincial Officer, made pursuant to Section 126 of the Environmental Protection Act.

Elmira Municipal Well E-9 was discovered to be contaminated on or about November 9, 1989, with N-Nitrosodimethylamine (NDMA) based on samples obtained on September 19, 1989. Further sampling has subsequently revealed at least six area private domestic wells contaminated with this contaminant, as well as Elmira municipal well E-7. This occurrence has been investigated by Technical Support staff. The purpose of this report is to summarize the results of the investigation (findings) and to make recommendations and conclusions regarding the source of the contamination and what remedial actions are necessary.

A review of available air emission information and surface water data was also performed. These aspects are included in the report along with appropriate conclusions and recommendations

1.2 Plant Location

Uniroyal Chemical Ltd. owns a 35 hectare parcel on the east side of Elmira. The Canagagigue Creek flows south through the property, splitting it into two portions. The company offices, plant and former operating lagoons are located west of the creek on 11 hectares.

The 24 hectares on the east side of the creek were once used for on-site waste disposal and currently contain buried pits which resulted from a 1969 cleanup and waste consolidation effort.

1.3 Background

Uniroyal Chemical Ltd. in Elmira has produced a wide range of organic chemicals for the agricultural, rubber and plastics industries since 1941. It was known as the Naugatuck Chemical Company in the forties and fifties. Prior to 1964, the company's liquid industrial wastes were disposed of by lagooning, or burial in unlined pits and by eventual discharge to Canagagigue Creek.

In 1964, the Ontario Water Resources Commission, Uniroyal Ltd. and the Town of Elmira, jointly funded the construction of a sewage treatment plant to receive municipal and industrial wastes. By 1969, all unlined pits were taken out of service.

Two pits on the east side of the property were plastic lined and filled with wastes from the other unlined on-site pits.

Ponds on the west side of the property were lined with compacted clay and remained in use for wastewater treatment up until 1986 when they were taken out of service as part of Uniroyal's decommissioning program.

By September, 1989, all of the ponds had been cleaned out and only RPW8 remains unfilled.

On, or about January 25, 1990 Mr. W. Ruck, General Manager for Uniroyal Chemical Ltd. in Elmira, gave to Mr. S. Salbach, a chart (Appendix H) which sets out the chain of ownership of Uniroyal Chemical Ltd., Elmira. This chart indicates that the company is owned and controlled by Uniroyal Chemical Company Investors Holding, Inc. through their ownership of the following companies; Uniroyal Chemical Holding Company, Uniroyal Chemical Acquisition Corporation, Uniroyal Chemical Co. Inc. of Painesville, Ohio and Uniroyal Chemical Ltd. of Canada.

2.0 SUMMARY

I have concluded that the contamination with NDMA of Elmira Municipal Wells E-7 and E-9 and at least six private domestic wells originated from the property of Uniroyal Chemical Ltd., and that the contaminations are the result of previous disposal and operating practices of that corporation and have caused an adverse effect contrary to Section 13 of the Environmental Protection Act. It is further concluded that wastewater discharges from Uniroyal Chemical Ltd. to the Elmira Sewage Treatment Plant (STP) have resulted in discharges from the Elmira STP that cause, or are likely to cause an adverse effect, contrary to Section 13 of the Environmental Protection Act.

It is further concluded that in addition to NDMA a number of other organic contaminants are migrating off-property at slower rates and that remedial measures both in the form of containment well pumping and treatment, and removal of source areas is needed in order to clean up the municipal aquifer and stop the migration of contamination, into the natural environment and, from the property.

It is further concluded that emissions to the natural environment, air, from Uniroyal Chemicals Ltd. cause or are likely to cause an adverse effect contrary to Section 13 of the Environmental Protection Act.

3.0 METHOD

Following the discovery of NDMA, and at the request of the District Officer, Cambridge District Office, staff of the Technical Support Section started the search for the contaminant source. The investigation included:

- i) review of available data and documents relating to groundwater in the Elmira area,
- ii) sampling and analysis of existing groundwater monitoring points,
- iii) obtaining water quality data from others working in the area, and
- iv) air emission information and data on the Uniroyal Chemical Ltd. effluents to the Elmira Sewage Treatment Plant and the resulting discharge to the Canagagigue Creek and Grand River, was also reviewed.

This report summarizes the significant evidence collected and makes appropriate conclusions and recommendations in the context of applicable environmental legislation.

4.0 SETTING

A detailed description of the setting and geology of the Elmira area is beyond the scope of this report. For details of this nature, references 1, 4, and 9 are recommended.

Figure 1 illustrates the general locations of the Uniroyal plant site with respect to the Town of Elmira, roads, and Canagagigue Creek which flows southward bisecting the Uniroyal property.

Figure 2 illustrates the location of the groundwater monitoring locations in the area, as they existed prior to November, 1989. Figure 3 illustrates the area in and around Uniroyal in greater detail.

The hydrogeology of the area is considered complex. However, most investigators have subdivided the geologic materials into five hydrogeologic units:

- i) the water table aquifer,
- ii) the upper silt till,
- iii) the middle aquifer (municipal aquifer),
- iv) the middle till,
- v) the lower sand and gravel/bedrock aquifer

Throughout this report, the terms "middle aquifer" and "municipal aquifer" are used interchangeably.

5.0 OBSERVATIONS AND CONCLUSIONS

This portion of the report reviews significant information collected in the investigation and makes conclusions in the context of applicable environmental legislation.

This report is based on data collected up to February 14, 1990, primarily by Ministry of the Environment forces and various consultant studies. Studies by CH₂M Hill Ltd. for the Region of Waterloo, and Morrison-Beatty Ltd. on behalf of Uniroyal Chemical Ltd., are continuing.

5.1 Groundwater Flow & Off-Site Contamination

Morrison-Beatty report (Reference 5) titled "Program to Assess Southwesterly Groundwater Movement" dated June, 1988, presents the results of a synchronized middle aquifer water level monitoring operation performed on July 29, 1987. The report states in Section 2.1.2 1987 Water Level Survey, that;

"the contours show a general southwesterly flow direction across the entire Uniroyal site towards the south well field. There is also a deflection of flow towards the west central boundary of Uniroyal. Water levels measured at other times during the the July survey showed the same pattern".

5.2 Monitoring Wells MOE-1

On March 24, 1987, Terraqua Investigations Limited, under contract to the Ministry of the Environment, installed groundwater monitors MOE-1(A), 1(B), 1(C), and 1(D), located approximately 150 metres due west of the Uniroyal property (Figures 2 and 3). Monitor MOE-1(B) in particular, is finished into the municipal aquifer to a depth of approximately 21 metres below ground surface. This monitor, along with others at this location, was sampled on March 3, 1988, and again on April 27, 1988. The results are provided in Appendix A.

In both samples, a variety of organic contaminants were detected, including aniline and nitrobenzene in high concentrations, plus halogenated benzenes, chlorophenolics, and phenoxyherbicides. These contaminants are characteristic of those previously found on and beneath the Uniroyal property.

5.3 Sulco Property

In August, 1988, Sulco Chemicals Limited, which is located southwest of the Uniroyal property, installed a water supply well (PW-1) and a monitoring well (OW-1)

into the municipal aquifer with the intent of obtaining inexpensive process water for their operations. The location of these borings is illustrated in Appendix B, Figure 2. The well was pump tested in September, 1988, and during the test, three water samples were collected and subsequently analyzed for general water quality parameters, volatile organics and pesticides. Acid and base neutral extractable analyses were not performed. The analytical results are included in Appendix B. The contaminants detected included aromatics, halogenated aliphatics, and traces of organochlorine pesticides, all of which have been previously detected on and beneath the Uniroyal property which is located upgradient from Sulco with respect to normal gradients in the municipal aquifer.

In their report (page 25, paragraph 2), Terraqua Investigations state;

"The organics constituents present in the first water sample collected from PW-1 indicates organic contaminant plume from Uniroyal is already under the Sulco site".

The location identifiers PW-1 and OW-1 are used for 2 locations on the Uniroyal property. These are not the same monitors as those referred to above on the Sulco property.

5.4 Monitoring Well CRA-3

Monitor CRA-3 is located due south of the Uniroyal property and is finished into the municipal aquifer. The monitor was originally constructed in January, 1983, by Conestoga Rovers Associates Limited under contract to the Ministry of the Environment to study the former First Street landfill. The landfill is located just south of the monitor. The monitor however, is upgradient from the landfill based on the flow in the municipal aquifer being toward the southwest and ultimately to Elmira's south well field (wells E-7 and E-9).

The monitor was sampled twice in 1988, and analyzed for volatile and extractable organics. Several characteristic Uniroyal chemicals were detected, including benzothiazolone, diethyl ether, chlorobenzene and benzene. N-Nitrosodimethylamine was detected at an approximate concentration of 34 µg/l in the June 6, 1988 sample.

It is concluded, based on the observations outlined above for monitor MOE-1B, the Sulco Limited production well PW-1, and monitor CRA-3, (Sections 5.1, 5.2, 5.3, 5.4) that contaminants have migrated and continue to

migrate from the Uniroyal property in the municipal aquifer.

5.5 Extent of Off-Property Contamination
Other than NDMA

The purpose of this section is to present information which confirms the presence of Uniroyal Chemical Ltd. contaminants other than NDMA beyond the Uniroyal Chemical Ltd. property, and extending at least as far as monitoring well 57-33 (Fig.2), located about 700 metres west-southwest of the Uniroyal property.

Monitoring well 18d is located on the western boundary of the Uniroyal Chemical Ltd. property (Figure 3) and finished to a depth of approximately 15 metres into the middle aquifer. Beginning in June, 1984, the monitor was equipped with an automatic water level recording device, which precluded sampling of the well. At the request of the Ministry of the Environment in early 1988, the recorder was removed and the well was subsequently sampled in late 1988, or early 1989. Analytical results for this sample are presented in Appendix I, along with the covering letter from Mr. Henri Huneault, Senior Chemist, Zenon Environmental Incorporated to Ross Duncan of Morrison-Beatty Limited, dated March 2, 1989.

The testing (18d) included an EPA 624 and EPA 625 priority pollutants Analysis which includes 30 and 52 contaminants respectively, and a GC/MS characterization scan. In the EPA 624 analysis, of 18d water. Ten volatile organic contaminants were detected, including benzene, toluene, xylene and ethylbenzene (BTEX's). The two highest concentrations were that of chlorobenzene at 3,200 µg/l, and benzene at 500 µg/l. In the EPA 625 list, nitrobenzene, (6.2 µg/l) 2-chlorophenol (420 µg/l), 2,4-dichlorophenol, (5.4 µg/l), and 4-chloro-3-methylphenol (20 µg/l) were detected as indicated. Fifteen compounds were detected and identified in the GC/MS scan.

Monitor 18d was then added to the groundwater monitoring program and therefore sampled again in April, 1989, along with the other monitors in the program. Samples were analyzed for 5 aromatics (BTEX) and 6 herbicides. Results for all wells monitored are included in Appendix I, along with a covering letter from H. Huneault (Zenon) to R. Duncan (Morrison-Beatty Limited) dated May 17, 1989.

It should be noted that within this data set BTEX were detected at high concentrations at 18d; (BTEX total 1,570 µg/l) and 106d; (BTEX total 3,320 µg/l), which is

also near the western property boundary of Uniroyal Chemical Ltd., but south of monitor 18d.

In September, 1989, 4 new monitors were installed by Morrison-Beatty Limited on behalf of Uniroyal. The locations of these monitors; 56-16, 56-25, 56-33, and 57-33 are shown on Figures 2 and 3 of this report. These monitors plus selected others were sampled by Morrison-Beatty on or about the period November 9 to 14, 1989, and analyzed for NDMA and EPA 624 and 625 listings. The results are included in Appendix I. Only monitors 56-33 and 57-33 are finished into the middle aquifer.

The following discussion is limited to monitor 57-33, as it is the monitor farthest from the Uniroyal Chemical Ltd. property. (Table 1 lists the contaminants detected at 57-33 and their concentrations).

Sample results from this monitor indicate that the middle aquifer is contaminated at this location. Sixteen organic contaminants were detected. At least two of these, Bis (2-ethylhexylphthalate) and Di-n-octylphthalate may result from the plastic well material used. The concentration of chlorobenzene and benzene were 1,2000 and 110 µg/l respectively. These are believed to reflect actual groundwater conditions.

The analytical results from monitor 57-33 were compared to monitors near the Uniroyal Chemical Ltd. property boundary; particularly monitors 18d and 106d, sampled within the last 18 months (see Table 1). The following seven contaminants were found in the middle aquifer at all three locations i.e. 18d and 106d at the Uniroyal Chemical Ltd. western boundary and at monitor 57-33; benzene, toluene, chlorobenzene, ethylbenzene, 2-chlorophenol, 2,4-dichlorophenol, and N-Nitrosodiphenylamine. It is concluded from this information that the middle aquifer from the Uniroyal Chemical Ltd. site to at least monitoring well 57-33 is contaminated and these contaminants have migrated from the Uniroyal site in the middle aquifer. Discussion of the NDMA contamination, apparent beyond monitor 57-33 extending to municipal wells E7 and E9, is included in Sections 5.8 and 5.9 of this report.

Various water quality analysis contained in Appendix A, B and I of this report have been reviewed by Dr. B. Birmingham of our Hazardous Contaminants Branch, Standards Development Section. He confirms that several water quality standards are exceeded by the local groundwater and that the water can be considered contaminated.

5.6 Buried Pits

Buried pits locally known as RPE-4 and RPE-5, (Figure 3) are located near Uniroyal's eastern property boundary. In 1969 or 1970, these pits were lined with plastic and filled with waste exhumed from other on-site disposal locations. At the time of the 1984 Control Order, it was not known to what extent the pits leaked and as a result, they were specifically targeted for further study in the 1984 Order. Morrison-Beatty Limited installed monitors and studied the pits on behalf of Uniroyal and prepared a report dated April 28, 1989, titled "Report on Groundwater Impact Assessment, Lined Waste Pits RPE-4 and RPE-5" (Reference 7). In Section 4, Conclusions, the report states:

- "1) The pits leak at a rate approximately equal to the infiltration into the pits.
- ii) Leaching of soluble contaminants from the pits to the groundwater will continue indefinitely at the present rate.
- iii) Contaminant loading from the pit effects groundwater quality in the middle aquifer downgradient of the pits. A portion of the observed impact may be due to the pre-1969 contaminant loading from the unlined pits."

Close examination of Figure 3 of the report (see Appendix C) labelled "Groundwater Flow - Lined Pit Area" reveals that shallow groundwater flow from the pits is toward the east in addition to south and west. The easterly component of flow, given the fact that the pits leak, likely causes, or will cause contamination beyond the Uniroyal property limits in the shallow aquifer.

It is therefore concluded that removal of the buried pits is needed in order to permanently eliminate the contaminant releases from this area of the site.

5.7 Dense Non-Aqueous Phase Liquid (D-NAPL)

Drilling performed during August, 1989 at the location of former operating pond RPW-5, (Figure 3) located in the central portion of the the Uniroyal property and on the west side of Canagagigue Creek, revealed the presence of dense, non-aqueous phase liquid (D-NAPL) at a depth of approximately 5 metres below surface. This corresponds to the base of the upper (water table) aquifer. Morrison-Beatty Limited on behalf of Uniroyal Ltd., undertook a preliminary sub-surface investigation in September, 1989 to determine if D-NAPL was present beneath the other former treatment ponds. D-NAPL was noted (at one location) beneath former treatment pond RPW-6 adjacent RPW-5. Morrison-Beatty prepared a report on this work titled "Report on a Preliminary D-NAPL

Investigation Former Operating Pond Area, Uniroyal Chemical Limited", dated October, 1989 (Reference 8). In Section 3.3 Analytical Results, the report states that the material was composed of the following contaminants:

- Toluene* (a lighter than water solvent)
 - Aniline*
 - Benzothiadiazole*
 - Methylbenzothiazole
 - Formanilide
 - Acetanilide
- (* = found at MOE-1(B))

The report also proposed further investigation to determine the spatial distribution of the material. This information is included in Appendix of this report.

It is concluded that this material has been discharged to the natural environment through seepage from the former process ponds, and that it represents a potential and likely contaminant source for further degradation of the shallow aquifer. It is further concluded that this material is responsible to a degree for the continued contamination of the middle municipal aquifer. The till layer separating the water table aquifer from the middle aquifer (municipal aquifer) is only 2 to 3 metres thick at this location.

5.8 Contamination of Municipal Aquifer with NDMA

N-Nitrosodimethylamine can be very mobile in the groundwater environment. It is extremely soluble in water.

Under Regulation 654/86, passed under the Occupational Health and Safety Act R.S.O. 1980, Chapter 321 as amended, NDMA is classified as a known toxic agent for which exposure values have not been established and for which any exposure should be avoided. (Appendix J). R. S. Tobin, Ph.D., Acting Chief, Monitoring and Criteria Division, of Health and Welfare Canada's Health Protection Branch indicated in his letter of November 19, 1989, (Appendix J) to Ms Ann Vajdic, Drinking Water Section, Ontario Ministry of the Environment that, "based on the potent carcinogenicity of NDMA in experimental animals, and its probable carcinogenicity in humans, it is recommended that exposure to this compound be minimized", and further that "it is desirable that concentrations of NDMA in drinking water be below the level of detection of the most reliable analytical method available". A subsequent letter from Dr. Tobin (January 12, 1990) suggests an interim guidance value of 0.012µg/l for NDMA in drinking water.

The interim guideline set by the Ontario Ministry of the Environment is 0.014 µg/l as noted in the letter from Ms A. Vajdic to Timothy C. Flannery dated February 13, 1990, also included in Appendix J.

Elmira municipal wells E-7 and E-9, located about 1.65 km south-southwest from the Uniroyal property were discovered to be contaminated with NDMA at approximately 4 µg/l on November 9, 1989, based on samples obtained on September 19.

Following the discovery, a program of monitoring well and domestic well sampling was initiated by Ministry staff, in order to identify any other contaminated wells and identify the source. By December 8, 1989, a total of 16 monitoring wells (some nested) and approximately 27 domestic wells had been sampled and analyzed for NDMA. The results of this phase of the investigation are reported in a technical memorandum from R. Hillier to D. Ireland, dated December 8, 1989, and referenced "Elmira Well Contamination, Status Report and Overview", (Appendix D). The survey revealed that five domestic wells (in addition to the two municipal wells) with NDMA concentrations, ranging from 0.2 to > 40 µg/l, and four monitoring wells with NDMA detected. Each of these monitors was downgradient from the Uniroyal property and in the municipal aquifer (or in a unit stratigraphically closely related to it). The detections are illustrated on the figure accompanying the technical memorandum.

The initial survey included samples obtained by Morrison-Beatty Limited for monitoring wells 18-d, 104d, and 106d which are located on Uniroyal Ltd. property. These were analyzed by Zenon Laboratories. NDMA was not detected in these samples.

The technical memorandum concluded that Uniroyal was the likely source area for the NDMA. In light of the lack of detections on the property, it recommended further investigation and sampling, specifically at Uniroyal.

Repeat sampling of the on-site (Uniroyal) wells plus other monitors followed. These locations included:

- i) 55-5 finished in the shallow water table aquifer beneath former treatment/process pond RPW-5, plus 19d, 18d, 106d
- ii) OW-1 and PW-1 located on the Sulco property
- iii) Monitors 56-25, 56-43, and 57-33 which are located between the Uniroyal property and municipal wells E-7 and E-9.

The results of this additional survey, combined with the previous sampling (earlier than December 8, 1989) are illustrated in Figures 4 and 5. NDMA was detected in an

additional domestic well, bringing the confirmed total to six.

A complete table of NDMA groundwater results is also included in Appendix E.

NDMA concentration reported for on-site Uniroyal wells 19d ($> 300 \mu\text{g/l}$), 18d ($1500 \mu\text{g/l}$) and 55-5 ($300 \mu\text{g/l}$) were the highest detected in the groundwater to date. Monitor 55-5 taps the water table aquifer at former pond RPW-5. At this location, the till aquitard (layer of lower permeability) is only 2 to 3 metres thick.

Wells 18d and 19d with 1500 and $> 300 \mu\text{g/l}$ NDMA respectively are both finished in the municipal aquifer along the western Uniroyal property boundary. Virtually all the monitoring wells and domestic wells between these points (18d and 19d) and municipal wells E-7 and E-9 exhibited the presence of NDMA. To date, monitor 57-33 has yielded a concentration of only $3.4 \mu\text{g/l}$. However, this value will likely rise with further well development. It has only been sampled twice.

In addition to the hydrogeological evidence outlined above, four other factors have been considered as follows:

- 1) On December 18, 1989, analytical results for the Uniroyal Water Treatment Plant effluent running to the Elmira STP were completed from samples taken on November 30, 1989. The concentration of NDMA in the effluent was $2000 \mu\text{g/l}$, thus confirming that Uniroyal was a generator of this contaminant.
- 2) Review of surface water quality data confirmed that in 1988, NDMA was detected in the effluent from the Elmira STP on three out of nine occasions sampled during that year. This confirmed that the 1989 results were not extraordinary (see Section 5.11).
- 3) File searches indicated that in 1977, the Uniroyal effluent sampled from the process/treatment ponds (Reference 2) contained NDMA at concentrations up to 130 mg/l . This apparently was caused by the TUEX process which was operated by Uniroyal at that time. The waste water from this process reportedly had a concentration of 340 mg/l .
- 4) The chemical dimethylamine (DMA) is a building block for the generation of NDMA under selected conditions (Otto Merez, Ph.D.,

Senior Environmental Scientist). DMA has been used by Uniroyal since 1944 (H. Soehner, former Uniroyal employee and member of Citizens Environmental Advisory Committee, personal communication). Wastewaters and tars from Elmira processes using DMA were discharged to the various process ponds located on the western half of the Uniroyal property. These ponds were unlined up until 1969.

Morrison-Beatty in their comprehensive report of 1985, (Reference 4) in Section 5.4 Impact of Operating lagoons indicate that even the lined ponds likely leaked at a rate of approximately 3400 l/d.

Based on all the information presented above, it is concluded that the contamination of municipal wells E-7 and E-9, at least six domestic well supplies, and an industrial well (Sulco well) with NDMA was caused by discharges into the natural environment originally taking place on the Uniroyal property in Elmira.

5.9 Effect of Cessation of Pumping at E-7 and E-9

Testing done by Morrison-Beatty Limited has confirmed that the north well field does have the ability to lower water levels in the municipal aquifer as far south as OW-16, located at the extreme south end of the Uniroyal property. When both fields were pumping, the flow remained to the southwest, in spite of the water level changes caused by the north field. This was outlined in Section 5.1.

On or about November 10, 1989, pumping from both E-7 and E-9 was ceased, leaving the north wells as the only major water takings from the municipal aquifer in the community. The pumping rate from the north field is likely higher than was normally needed before. Under these conditions, the flow direction from the Uniroyal site will be toward the north well field (wells E-2, E-5, E-6 and E-8).

It is concluded that in the short term, pumping either of E-7 or E-9 should be restarted with suitable treatment to destroy NDMA so as to re-establish the pre-contamination flow régime, and thereby protect the north well field from contamination.

It is likely that a more optimal location than E7 and E9 exists for cleaning the contaminant plume and maintaining protection of the north field. It is concluded therefore, that acceleration of the cleaning process could be achieved in the longer term by

relocating the containment well pumping some distance north of the E-7/E-9 location.

5.10 Air Emissions

Tables 1 and 2 (Appendix G) list complaints lodged against the Uniroyal facility by residents. Progress reports for air emissions submitted to the Ministry of the Environment by Uniroyal have identified specific areas reviewed as follows:

- A. Bldg. 14 SO₂ stack
- B₁ Bldg. 44 stack
- B₂ SO₂ Emissions, Bldg. 44
- C. NOx Fumes, Bldg. 37
- D. Carbon Absorption Towers, Bldg. 2
- E. Scrubber System, Pilot Plant
- F₁ NOx Emissions, Bldg. 14
- F₂ Amine Emissions, Bldg. 14
- G. Potential Emissions, Wetox
- H. Potential Emissions Dissolved Air Flotation Unit

Within the text of the progress reports for air emissions, #5 (December 1, 1986 to January 1, 1988) and #6, (January 1, 1988 to December 31, 1988) and the monthly complaint reports submitted to the Ministry of the Environment by Uniroyal for June, July, August, September and October, 1989 Appendix 6, (Table 3) certain sources were considered attributable or potentially attributable to odour complaints. The company responded on occasion in the following fashion:

- 1. Bldg. #14 incinerator shutdown
- 2. Wetox Unit put on standby/shutdown
- 3. Bldg. #44 put on standby/shutdown
- 4. Pilot plant process shutdown

Several complaints were attributed to the operating lagoons which have been eliminated.

As a result of the continued odour complaints and the Company's acknowledgment of attributable or potentially attributable sources, it is considered that on occasion, emissions to the natural environment, air, contravene Section 13 of the Environmental Protection Act. An odour audit of all sources is warranted with specific emphasis given to the above four sources.

5.11 Surface Water Discharges

Since November, 1989, sampling within the Elmira STP and downstream, has repeatedly detected the presence of NDMA. The Uniroyal effluent entering the STP contained 2000 µg/l November 30, 1989. There are no other inputs to the sewer line that connects Uniroyal to the STP.

Subsequent sampling revealed lower concentrations (>300, >100, 200, 150, 180, 190 and 250 µg/l) through January 15, 1990 (see Appendix E). The concentration of NDMA in the town input to the Elmira STP was non-detect over the same period. On January 19, 1990, the concentration of NDMA in the Town effluent(s) were 0.034 and 0.055 µg/l. On January 22, 1990, NDMA concentrations in the Town sewage were 0.072 and 0.067 µg/l and on February 1, 1990, the concentrations were 0.046 and 0.16 µg/l. These values are considered minor inputs to the Elmira STP compared to that of Uniroyal's effluent.

NDMA concentrations in the STP effluent were 50 µg/l November 30 and at lower levels thereafter (0.87, 1.1, NO (2.0) 0.21, 0.24, 0.26, 0.4, 0.8 and 0.59 µg/l through the same period. NDMA was detected in the Canagagigue Creek at the first bridge downstream from Elmira in two samples collected December 20, 1989 at concentrations of 0.21 and 0.34 µg/l. Further downstream in the Grand River, NDMA was measured in raw water at the Water Treatment Plants (WTPs) in Brantford, Ohsweken and Cayuga, generally near the detection limit (0.010 µg/l), but as high as 0.015, 0.037, and 0.078 µg/l respectively.

The discharge of Uniroyal Ltd. effluent to the Elmira STP ceased over the period January 18 to 21, 1990. Flows from Uniroyal began at lower rates again on January 26, 1990. During this period (January 21-26, 1990), the concentration of NDMA in the STP effluent declined markedly. Samples taken January 22, 24 and 26, 1990, indicated 0.060, 0.012 and 0.180 µg/l NDMA respectively. It is concluded from this information that the Uniroyal Ltd. discharge to the Elmira STP is a major factor controlling the NDMA concentration in the Elmira STP effluent.

Shirt Factory Creek flows easterly through the urban area of Elmira, and the Uniroyal Ltd. property ultimately discharging to Canagagigue Creek just north of the former process lagoons.

Landfill Creek (local name) drains the area around the former First Street Landfill and discharges to Canagagigue Creek, 300 metres south of the Elmira STP.

Quarterly sampling of Canagagigue Creek, Shirt Factory Creek and Landfill Creek, plus the Elmira STP, discharge during the period January, 1986 to August, 1989, has revealed the occurrence of a number of organic contaminants. Routine scans (excluding GC/MS) and detection limits, have produced a total of 72

quantifiable detections of one or more parameters from a group of 28 organic compounds, in the STP effluent. Data are presented in Appendix F. The list includes the dates and concentrations involved, as well as reference to Provincial Water Quality Objectives and Guidelines (PWQO/Gs) concentrations, where available. Twenty-five per cent of those detections (a total of 18 occurrences) were exceedences of the PWQO/Gs and 13 occurrences involved the organochlorine pesticide Lindane. Of the combined total, 39 detections of Lindane in the STP effluent and the creeks, 30 were PWQO exceedences. Other compounds present included organochlorine and phenoxy acid pesticides, halogenated hydrocarbons and chlorophenols.

GC/MS scans, used during the 1986 to 1989 program mentioned above, have revealed the periodic occurrence of 4-nitroso morpholine (7 times at a range of 0.8 to 120 µg/l) and N-nitroso diethylamine (once at 3 µg/l) in the STP effluent, and N-nitroso diphenylamine (once at 37 µg/l) in Shirt Factory Creek. All three are considered positive animal carcinogens by the International Association for the Registration of Carcinogens (AIRC). The USEPA recommends treating them as human carcinogens (Ambient Water Quality Criteria, USEPA Office of Water Regulations and Standards, Update 1.0, September 2, 1986).

It is therefore concluded that Uniroyal Chemical Ltd. via their discharges to the Elmira STP and Shirt Factory Creek, have caused an adverse effect pursuant to Section 13 of the Environmental Protection Act and that a thorough audit of their processes and waste treatment practices is needed.

6.0 FINDINGS

- 1) Seepage from the lined buried pits identified as RPE-4 and RPE-5 (Figure 3) has contaminated groundwater on-property in both the shallow water table aquifer and the intermediate (municipal aquifer) beneath the site, constituting impairment of the quality of the natural environment for any use that can be made of it, contrary to Section 13(1) of the Environmental Protection Act.
- 2) The seepage from the lined pits RPE-4, and RPE-5 (Figure 3) has migrated easterly in the shallow aquifer and contaminated groundwater beyond the Uniroyal property limits at this location, constituting impairment of the quality of the natural environment for any use that can be made of it, contrary Section 13(1) of the Environmental Protection Act.
- 3) Seepage of numerous organic contaminants, including NDMA from the former operating process lagoons RPW-5, 6, 7, and 8 (Figure 3) into the natural environment, the shallow aquifer has occurred. This includes the Dense Non-Aqueous Phase Liquid (DNAPL) found at the base of the shallow aquifer beneath RPW-5 and RPW-6. These contaminants have caused and are likely to continue to cause impairment of the quality of the natural environment for any use that can be made of it, contrary to Section 13(1) of the Environmental Protection Act.
- 4) Contaminated groundwater has migrated from the water table aquifer on the Uniroyal property down to the municipal aquifer and within this aquifer has migrated to the west and southwest, away from the Uniroyal owned lands, thus causing impairment of the natural environment for any use that can be made of it, contrary to Section 13(1) of the Environmental Protection Act.
- 5) The contaminated groundwater has rendered unsuitable for human consumption, two municipal wells, at least six domestic wells and one industrial well, thus rendering the wells unfit for use by man and potentially causing an adverse effect on the health of any person, contrary to Section 13(1) of the Environmental Protection Act.
- 6) Wastewater discharges from the Uniroyal Chemical Ltd. property to the Elmira Sewage Treatment Plant have resulted in discharges from the Elmira Sewage Treatment Plant to the natural environment, surface water the Canagagigue Creek and Grand River,

impairing the quality of these surface waters for any use that can be made of it and that may cause or is likely to cause an adverse effect on the health of any person, contrary to Section 13(1) of the Environmental Protection Act.

- 7) Emissions to the natural environment, air, from Uniroyal Chemical Ltd., have caused or are likely to cause impairment of the quality of the natural environment, air, for any use that can be made of it, and have caused or are likely to cause loss of enjoyment of the normal use of property, contrary to Section 13(1) of the Environmental Protection Act.

6.0 RECOMMENDATIONS

It is recommended that Uniroyal Chemical Ltd. be ordered to do the following and that the Terms and Conditions of the proposed Order read as follows:

Progress Reports

- 1) a) By the 15th day of the second month after receipt of this Order, and by the 15th day of each month thereafter, unless otherwise specifically provided in this Order, submit to the Regional Director, West Central Region, a written report which summarizes progress made towards achieving all conditions contained in this order during the preceding month. The initial and subsequent monthly written reports must contain but not be limited to any and all analytical data pertaining to bench scale testing, pilot scale testing, aquifer testing, and contain records of all significant contacts made with potential contractors and consultants, regarding obtaining equipment and services and necessary approvals. The written reports should specify the methodology followed in any analysis or sampling, the individual(s) responsible for such work, the time of the work and its location. Protocols and methodology for sampling and analysis should be described in the initial submission and any changes in the protocols or methodology should be identified in subsequent reports as the changes occur.

In the event that a report including data is required within 90 days of sampling, the analytical data may be included in that report, and need not be reported in the routine monthly report. In any case, specific data will be provided to the Ministry of the Environment on request of the Director, West Central Region.

Containment Wells for Contaminated Groundwater

- 2 a) Upon receipt of this Order, immediately investigate treatment alternatives for recovered contaminated groundwater obtained by the pumping of containment wells referred to in Paragraph 2(b).
- b) Within 45 days of the issuance of this Order, submit to the Director, Approvals Branch and the Regional Director, West Central Region, an application for a Certificate of Approval for a Sewage Works, pursuant to Section 24(1) of Ontario Water Resources Act, or a report detailing proposed sewage works for the Director's approval if there is no proposed discharge to the natural environment. The proposed sewage works will collect and

treat contaminated groundwater from beneath the Uniroyal Chemical Limited property, Elmira as in Figure 1 of the report of Provincial Officer R. Hillier, at sufficient volume to eliminate further migration of contaminated groundwater from the property. The sewage works will operate by means of one or more pumping containment wells, established on the Uniroyal Chemical property. The sewage works will include treatment of the collected contaminated groundwater prior to discharge to the natural environment to meet discharge criteria as specified in the Certificate of Approval.

- c) Within 150 days of obtaining either the Certificate of Approval or the Regional Director's approval referred to in paragraph "2b" of this part, the sewage works referred to in the aforementioned paragraph shall be put into operation pursuant to the conditions of the Certificate of Approval issued by the Director of the Approvals Branch.
- d) Within 90 days of the commencement of the operation of the approved sewage works, submit a report detailing the performance of the sewage works.

Longterm Collection and Treatment System

- 3) a) Within 120 days of the issuance of the Order, submit a written report for the approval of the Director, West Central Region, detailing and recommending a long-term alternative collection and treatment system which would optimize the aquifer cleaning process for removal and treatment of NDMA and any other contaminants* present, in the aquifers including, without restricting the generality of the foregoing, the compounds listed in Appendices "A", "B", and "I" of Provincial Officer Hillier's Report attached to this Order. The collection and treatment system should also prevent the further contamination of potable ground water supplies. The report shall include, but not be limited to recommendations for an implementation date for the system, well(s) locations on and off Uniroyal property, treatment equipment and methods, and predictions of system performance regarding cleaning the aquifers.

* **Contaminants** as it is used in this Order, include solids, liquids or gases or any combination thereof that may have an adverse effect on the environment, humans or animals. **Adverse effect** includes potential or actual, material discomfort, property damage, interference with enjoyment of property, impairment of health or public safety.

- b) The report in paragraph 3(a) shall be prepared by a qualified consultant acceptable to the Director, West Central Region and approved by him prior to carrying out the work. The consultant selected must have experience in the preparation of reports recommending options for the collection and treatment of contaminants in groundwater, the implementation of such options and the familiarity with the options for collection and treatment of groundwater contamination.
- c) Upon approval of the report submitted pursuant to Paragraph 3(a) by the Director, West Central Region, obtain the necessary approvals required and implement the alternative recommended by the report, forthwith.

Environmental Audit

- 4) a) Within 45 days of the issuance of this Order, prepare and submit to the Director, West Central Region for his approval, terms of reference including a monitoring plan and sampling schedule, for a written comprehensive environmental audit report for his approval on the operations of Uniroyal Chemical Limited, Elmira. The report will provide detailed information concerning the emissions and discharges of contaminants into the natural environment, air, surface water, and groundwater, and deposits of wastes by Uniroyal Chemical Limited on their property and an inventory of wastes and locations if disposed of off their property within the municipality of the Township of Woolwich. The report will provide detailed information concerning all process operations, including raw materials, intermediates and products, and the waste materials formed and disposed of from each. For ease of reporting, any confidential or proprietary information should be reported in a separate appendix and identified as confidential. The report must be acceptable to the Director, West Central Region in accordance with the terms of reference approved by the Director, West Central Region, and submitted within 180 days of approval of the terms of reference. The report must include an assessment of compliance with EPA and OWRA of discharges, emissions and deposits of waste.
- b) The report shall be prepared by a qualified consultant who has experience in preparing comprehensive environmental audits on the potential pollution of chemical plants. The Consultant shall be approved by the Director, West Central Region before any of the work is carried out.

- c) An annual report shall be submitted detailing changes at the plant and their effects on the emissions, effluents and wastes disposed of or discharged to the natural environment. The first report is due one year after submission of the Audit Report and yearly thereafter.
- d) Within 90 days of submitting the report referred to in paragraph 4(b) of this Part, provide details of the remedial measures and an implementation schedule to remedy non-complying on-site wastes, emissions and effluents, which meets with the approval of the Director, West Central Region.

Removal of Wastes in Buried Pits

- 5 a) By July 30, 1990, submit for the approval of the Director, West Central Region, a detailed written report acceptable to the Director, West Central Region, for the excavation, treatment and disposal of waste materials contained in the two buried pits (RPE-4 and RPE-5) on Uniroyal Chemical Ltd. property, Elmira shown on Figure 3 of the report of Provincial Officer R. Hillier. The report will provide detailed information concerning waste characterization, removal procedures, air and groundwater monitoring, methods for protection of air and water quality, methods of disposal of wastes and an implementation schedule and a proposal for a post monitoring and assessment program.
- b) The report referred to in Paragraph 5(a) shall be prepared by a qualified consultant acceptable to the Director, West Central Region and approved by him prior to the work being carried out. The consultant must be experienced in preparing reports on waste excavation, treatment and disposal, the monitoring of air and groundwater and the recommendation of options for the protection and remediation of the natural environment.
- c) In the event that interim on-site storage of excavated material referred to in Paragraph 5(a) of this section is required at the time of excavations, in the opinion of the Director, West Central Region, Uniroyal Chemical must apply immediately for a Certificate of Approval for a Waste Disposal Site, Transfer Station, pursuant to Part V of the Environmental Protection Act, for the interim

storage of excavated waste materials and prior to excavation of waste material.

- d) Within 180 days of obtaining the Certificate of Approval, in paragraph (5c) construct the storage facility as approved.
- e) Upon approval of the report submitted pursuant to paragraph 5(a) by the Director, West Central Region, obtain the necessary approvals required and implement the proposal such that waste materials have been excavated, treated, disposed of or placed into interim on-site storage described by paragraph (5c) by December 31, 1992.


Remediation of Former Operating Pond Area

- 6) a) Upon receipt of this Order immediately proceed with the investigation program referred to in the report by Morrison-Beatty Ltd. entitled "Report on a Preliminary DNAPL Investigation, Former Operating Pond Area, Uniroyal Chemical, Elmira", dated October, 1989. (See Provincial Officer's Report Appendix L.)

The results of the program shall be submitted in a written report for the approval of the Director, West Central Region within 150 days of the issuance of this Order.

The report submitted shall include a proposed remedial program for the elimination of DNAPL as a contaminant source, including an implementation schedule for the program and a program for post-monitoring and assessment.

- b) Upon approval of the report submitted pursuant to condition 6(a) by the Director, West Central Region, immediately take all steps to obtain the necessary approvals required to implement that report. Complete the remedial program for the elimination of DNAPL as a contaminant source by December 31, 1992.


PREPARED BY:
D.R. Hillier
Provincial Officer


DATE

8.0 REFERENCES

- 1) Canviro Consultants
Research and Development of Permanent On-site
Solution for Contamination of Groundwater at Waste
Disposal and Industrial Sites in Canada, Phase 1
Report for Supply and Services Canada, Contract
KE405-7-6557/OE-FE, Draft Report, June, 1989
- 2) Ministry of the Environment
Identification and Quantification of Dimethyl
Nitrosamine in Effluents of Uniroyal Company Ltd.,
and Elmira WPCP, Report OTC 7706, June 27, 1977
- 3) Ministry of the Environment
Preliminary Groundwater Evaluation of the Uniroyal
Operation in Elmira, 1979
- 4) Morrison-Beatty Limited
Comprehensive Hydrogeologic Report (MOE Control
Order Section 2) Uniroyal Ltd., Elmira,
November, 1985
- 5) Morrison-Beatty Limited
Program To Assess Southwesterly Groundwater
Movement, for Uniroyal Limited, June, 1988
- 6) Morrison-Beatty Limited
MOE Control Order Section 12 Groundwater
Monitoring, Report No. 7, on Water Level and Water
Quality Data, Uniroyal Chemical Limited, Elmira,
January, 1989
- 7) Morrison-Beatty Limited
Report on Groundwater Impact Assessment, Lined
Waste Pits RPE-4 and RPE-5, Uniroyal Chemical,
Elmira, April, 1989
- 8) Morrison-Beatty Limited
Report on a Preliminary D-NAPL Investigation Former
Operating Pond Area, Uniroyal Chemical, Elmira,
October, 1989.
- 8) Terraqua Investigations Limited
Hydrogeological Review of the Uniroyal Plant Site,
Elmira, for the Ministry of the Environment,
August, 1987
- 10) Terraqua Investigations Limited
Hydrogeological Investigation for a Proposed Water
Supply Well, for Sulco Chemicals, Elmira Draft
Report, December, 1988



Figure 1 GENERAL SITE PLAN
ELMIRA AND VICINITY

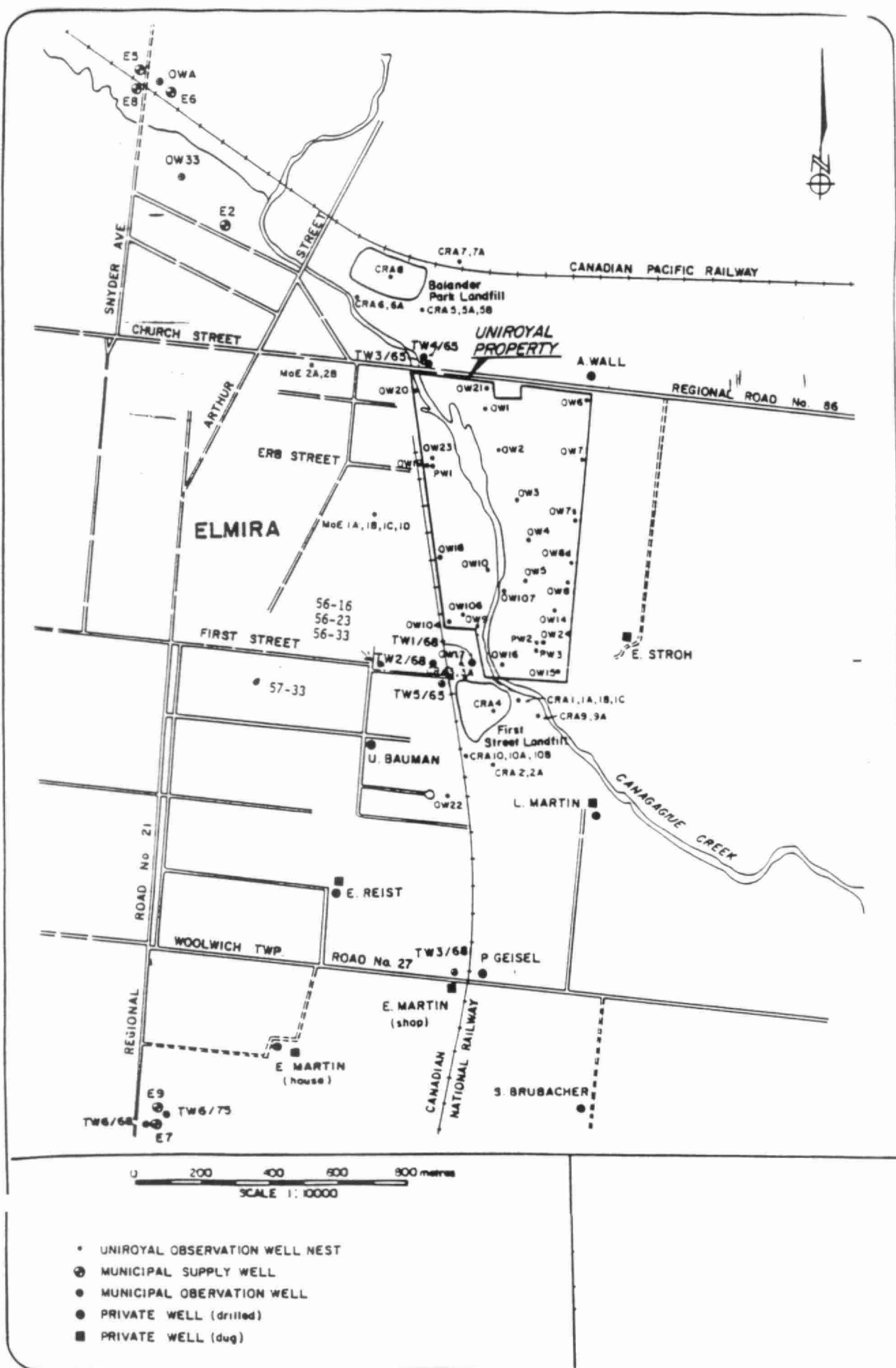


Figure 2 GROUNDWATER MONITORS AND MONITORED DOMESTIC WELLS (pre. November 1989)

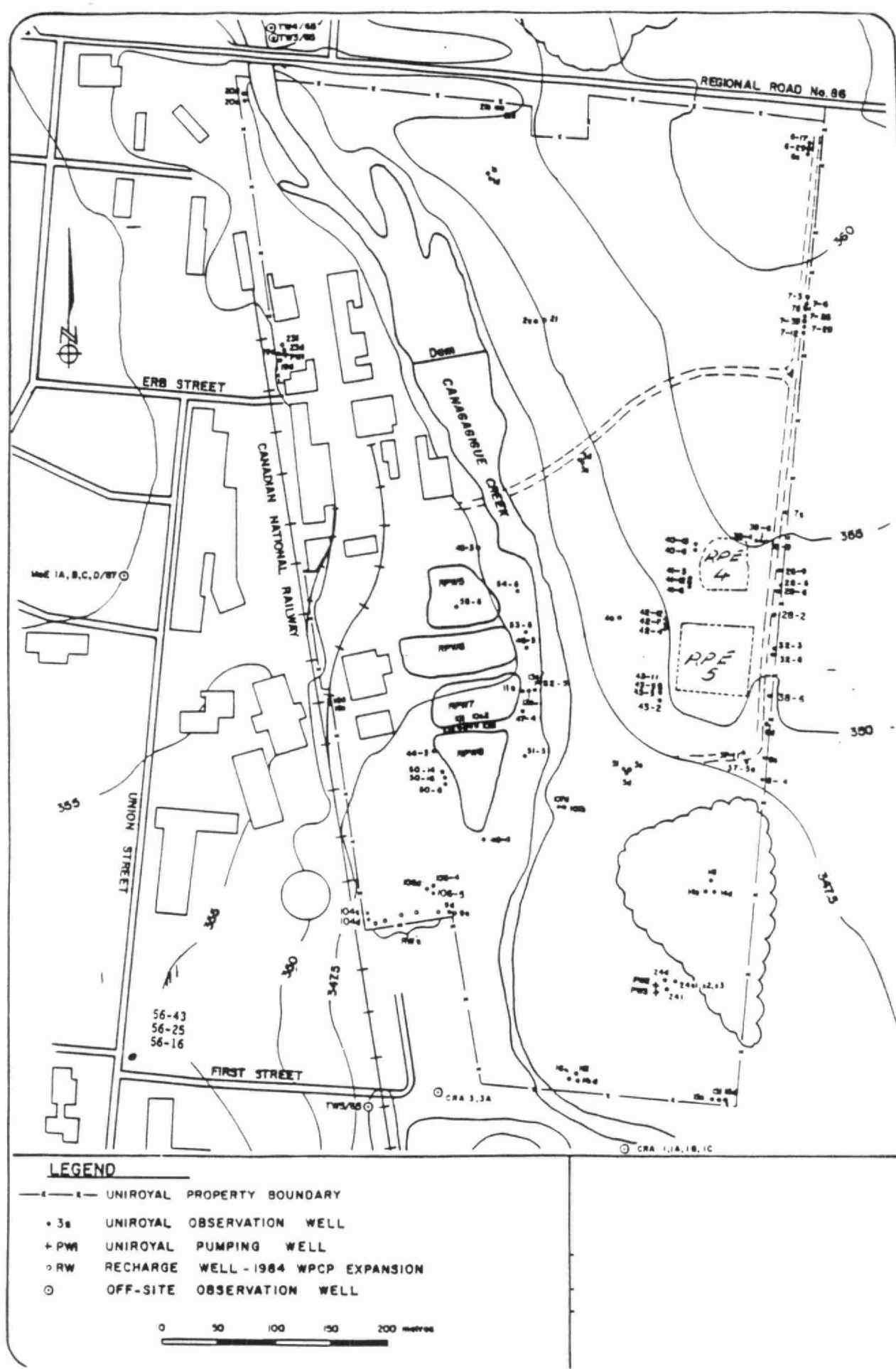


Figure 3 GROUNDWATER MONITORS AT UNIROYAL LTD.
AND VICINITY (pre. November 1980)

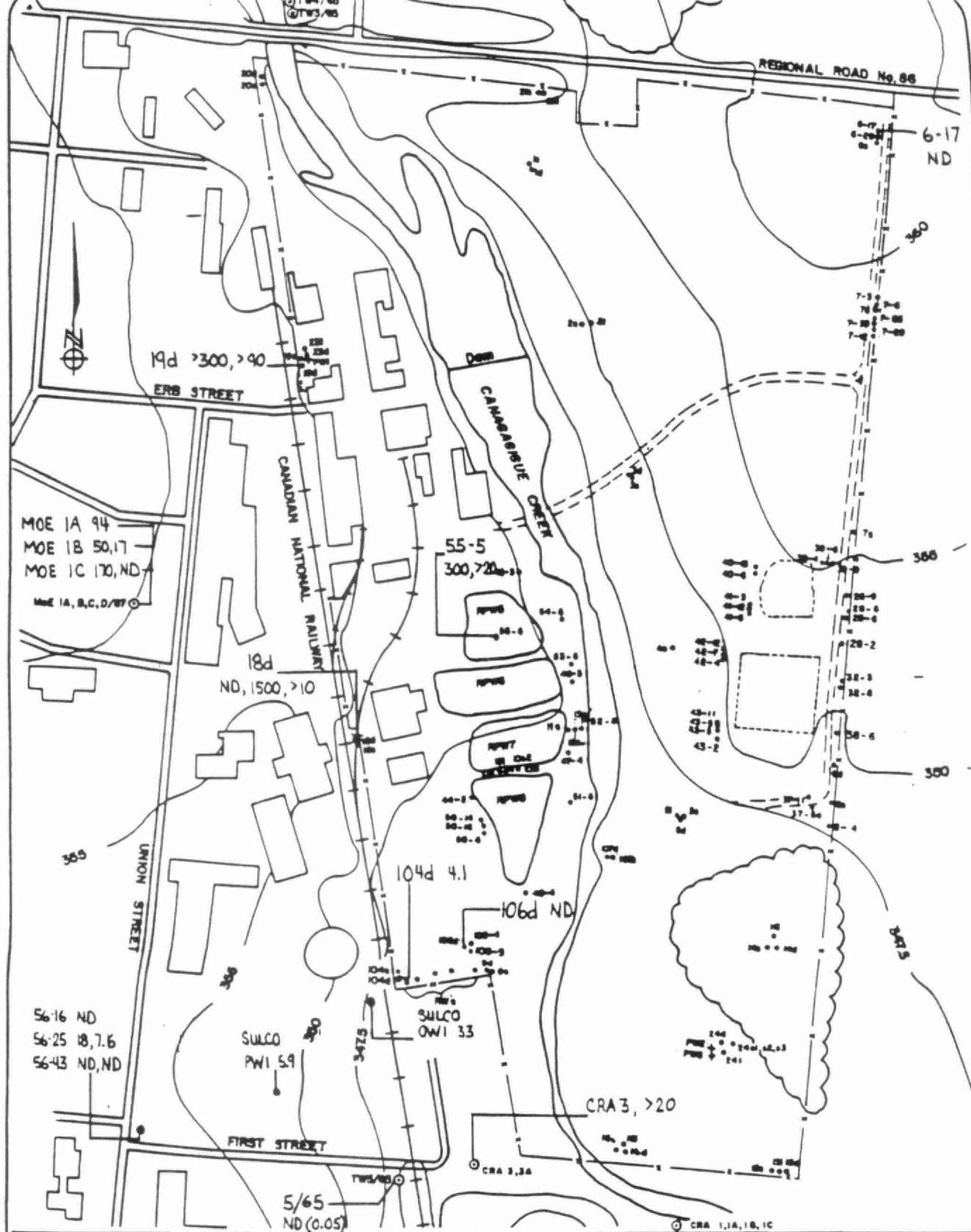


FIGURE 4

NDMA (UG/L) CONCENTRATION IN
UNIROYAL MONITORING WELLS

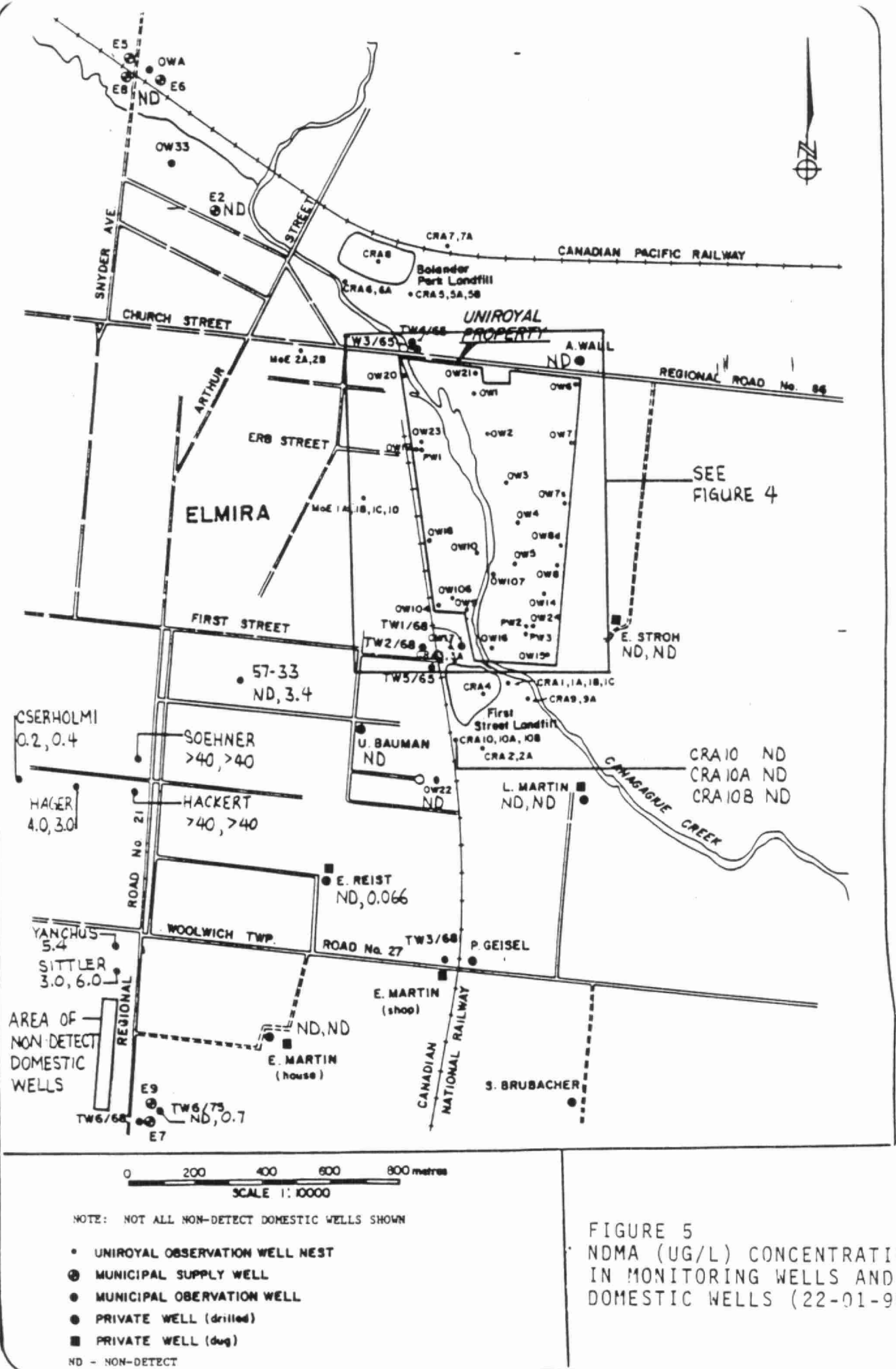


TABLE (1)
COMPARISON OF ORGANICS DETECTED AT
LOCATION 57-33, TO LOCATIONS 18D AND 106D

Parameter	57-33 (Nov.9/89)	18d (late 1988)	18d (Apr./89)	18d (Nov.9/89)	106d (Apr./89)	106d (Nov.14/89)	Selected Water Quality Criteria
<u>EPA 624 Priority Pollutants</u>							
1,1-Dichlorethene	2.7	-	NA	-	NA	-	-
trans-1,2-Dichlorethene	1.3	-	NA	-	NA	-	-
1,1-Dichloroethane	12	-	NA	-	NA	-	-
Chloroform	3.1	3.2	NA	-	NA	-	100 (EPA-MCL)
1,1,1-Trichlorethene	6.4	-	NA	-	NA	-	-
Benzene	110	500	820	-	310	-	5.0 (MAC)
Trichloroethene	0.93	-	NA	-	NA	-	5.0 (EPA-MCL)
Toluene	16	9.7	-	-	500	-	<24. (AO)
Tetrachloroethene	1.3	-	NA	-	NA	-	500 (EPA-DWEL)
Chlorobenzene	1200	3200	NA	46,000	NA	9200	60. (EPA-MCLG)
Ethylbenzene	3.1	11	140	-	580	-	<2.4 (AO)
<u>EPA 625 Priority Pollutants</u>							
2-chlorophenol	4.3	420	NA	1400	NA	230	-
2,4-dichlorophenol	7.5	5.4	NA	920	NA	400	900 (MAC), 0.3 (AO)
n-nitrosodiphenylamine	15	-	NA	56	NA	230	4.9 (EPA-AWQC)
Bis (2-ethylhexyl) phthalate	6.2	-	NA	-	NA	-	-
Di-n-octylphthalate	2.0	-	NA	-	NA	-	-

NOTES: (MAC) Health and Welfare Canada maximum acceptable concentration
 (AO) Health and Welfare Canada aesthetic objective
 (EPA-MCL) United States Environmental Protection agency (USEPA) maximum contaminant level
 (EPA-DWEL) USEPA Drinking Water Equivalent Level
 (EPA-MCLG) USEPA Maximum Contaminant Level Goal
 (EPA-AWQC) USEPA Ambient Water Quality Criteria
 NA Not Analysed
 - Not Detected

APPENDIX "A"

- Water quality analysis for monitoring well MOE-1 for March 3, 1988 and April 27, 1988.

MINISTRY OF THE ENVIRONMENT
LABORATORY SERVICES BRANCH
DRINKING WATER ORGANICS SECTION
MASS SPECTROMETRY ANALYTICAL REPORT

To: Wally Rosenberg Hamilton Regional Office
West Central Region

Re: GC/MS Analysis of Elmira - Unimyal
Ground Water Study samples

Submission No: WCWR 0004

MS Reference No.	Other Lab No.	Sample Description
<u>MY10-0206/209</u>		<u>Leachate</u>

For additional information contact: Dr. V.Y. Taguchi
(416) ~~248-3755~~ 235-5804
(416) ~~248-7488~~

c. c. H. Posina.
L.I.S.

Dr. O. Meres.

Volatile organics were analyzed by a purge-and-trap system followed by gas chromatography/mass spectrometry (GC/MS).

The concentrations of the components on the target compound list are quantitative and were calculated relative to external standards and the internal standards bromochloromethane and 1,3-dichlorobutane.

The concentrations of all other components found are semi-quantitative and were calculated relative to the internal standard 1,3-dichlorobutane.

Extractable organics were determined in the following manner:

The sample was partitioned into base/neutral (B/N) and acid fractions and extracted with methylene chloride.

The concentrated extracts were analyzed by gas chromatography/mass spectrometry (GC/MS).

The concentrations of the components found are semi-quantitative and were calculated relative to the internal standard d₁₀ phenanthrene.

The analytical data are presented in the attached
tables. The major part of the unidentified compounds
are nitrogen, or nitrogen and sulfur, containing compounds.

Reference:

LIS Submission No: WCLR0004

Date of Analysis: 88 03 16

V. Y. Taguchi
V. Y. Taguchi, Ph.D.



Date Sampled: 88 03 03

WCWR 0004

Date Analyzed: 88 03 05

Samples MY10 - 0206 to 209 (4)

ELMIRA - UNIROYAL

MONITORING WELL 1A-87

Compound	MY10	after 200L (5mL) -0206	after 400L (10mL) -0207	after 22L (10mL) -0208	after 12L (100mL) -0209
Methylene Chloride		ND (20)	ND (10)	ND (10)	ND (1)
1,1-Dichloroethylene		ND	ND	tr	ND
I.S. Bromochloromethane		✓	✓	✓	✓
1,1-Dichloroethane		ND	tr	1.3	ND
Chloroform		ND (10)	ND (5)	ND (5)	ND (0.5)
1,2-Dichloroethane		ND	ND	ND	ND
1,1,1-Trichloroethane		ND	ND	ND	ND
Carbontetrachloride		ND	ND	ND	ND
Dichlorobromomethane		tr	ND	ND	ND
1,2-Dichloropropane		ND	1.0	tr	ND
Benzene		100	71	97	0.4
Trichloroethylene		tr	2.0	2.5	ND
1,1,2-Trichloroethane		tr	ND	ND	ND
Chlorodibromomethane		ND	ND	ND	ND
1,2-Dibromoethane		ND	ND	ND	ND
Bromoform		ND	ND	ND	ND
I.S. 1,3-Dichlorobutane		✓	✓	✓	✓
Trichloroethylene		ND	ND	ND	ND
Toluene		2.0	1.9	32	0.2
1,1,2,2-Tetrachloroethane		ND	ND	ND	ND
Chlorobenzene		35	28		ND
Ethylbenzene		ND	ND	ND	ND
m-Xylene		ND	ND	ND	ND
o- or p-Xylene		ND	ND	ND	ND
1,2-Dichlorobenzene		ND	ND	ND	ND
ND level - less than		1	0.5	0.5	0.05
tr trace - less than		2	1.0	1.0	0.1

I.S. - internal standard

ND - not detected - less 0.05 ug/litre

ND† - not detected - less than 5 ug/litre

tr - trace - less than 0.1 ug/litre

* - approximate - response of standard not determined

NOTES

Ministry
of the
Environment

VOLATILE
ORGANIC

Components Found & Their Concentration in ug/L
relative to 1,3-dichlorobenzene...

page 2 of 5

WC NR 0004

Date Sampled: 88 03 03

Date Analyzed: 88 03 05

Samples MY10-0206/209 (4)

ELMIRA - UNIROYAL MONITORING WELL 1A-87

~~ND - not detected - less than 0.05 ug/litre~~

~~ND | not detected - less than 5 ug/litre~~~~tr - trace - less than 0.1 ug/litre~~~~* approximate response of standard not determined.~~

NOTES



Date Sampled: 88 03 03

WCWR0004

Date Analyzed: 88 03 12

Samples MY10-0206 to 209/4

ELMIRA UniROYAL GROUND WATER Study - MONITOR WELL

Compound	My10	1A-87 after 200L (800ml) - 0206	1A-87 after 400L (800ml) - 0207	1B-87 after 22L (800ml) - 0208	1C-87 after 12L (800ml) - 0209
<u>Oxygen-containing Compounds:-</u>					
- 2-ethyl-4-methyl-1,3-dioxolane		16	7	3	
- 2,5-dimethyl-1,4-dioxane		15	9	5	
- a C2 alkyl-1,4-dioxane			1	8	
- a C2 alkyl-1,4-dioxane		10	9	4	
- a C8 alcohol		12	9	7	
- a C9 alcohol				8	-
- tetramethoxyethane		4	3		
- 3-methyl-2-cyclohexen-1-one		15	10		
- n-butyl ether				4	
- a C12 ketone				2	0.5
- a C9 ester				3	
- a C10 ester					1
<u>Nitrogen-containing Compounds:-</u>					
- aniline				2300	
- azobenzene				3	
<u>Nitrogen-sulfur-containing Compounds:-</u>					
- tetramethylthiourea		2	+		
- benzothiazole		16	14	2	

+ - present - not quantitated.

ND - not detected - less than 0.05 ug/litre

ND+ - not detected - less than 5 ug/litre

tr - trace - less than 0.1 ug/litre

* - approximate - response of standard not determined

NOTES



Date Sampled: 88 03 03

WCWR0004

Date Analyzed: 88 03 12

Samples MY10-0206 to 209(4)

ELMIRA UniROYAL GROUND WATER STUDY - MONITOR WELLS

Compound	My10	1A-87 after 200L (800ml) - 0206	1A-87 after 400L (800ml) - 0207	1B-87 after 22L (800ml) - 0208	1C-87 after 12L (800ml) - 0209
<u>Nitrogen - oxygen-containing Compounds:-</u>					
- diethyl formamide		4	6		
- N-ethyl-N-nitroso-ethylamine		8	5		
- tetramethyl urea		35	14		
- nitrosobenzene				15	
- nitrobenzene				5900	
- ethyl morpholine		100	38		
- nitrotoluene				5	-
- N,N-diethyl-3-methyl-benzamide		50	16	36	0.9
- azoxybenzene				2	
<u>Nitrogen-sulfur-oxygen containing Compounds:-</u>					
- isothiocyanato benzene		8	4		
- 2(3H)-benzothiazdione		130	190	48	
- carboxin		64	94	10	
- 2H-1,4-benzothiazin-3(4H)-one		6	7		
<u>Sulfur-containing compounds:-</u>					
- methyl-1-(methylthio) propyldisulfide		14			
- 1,4-oxathiane		2			
- methyl 2-methyl-1,3-oxothiolan-2-yl ketone		7	7		
<u>Miscellaneous:-</u>					
- chlorobenzene				200	
- dimethyl phthalate				1	
- diethyl phthalate				6	
- tetramethyl butyl phenol				4	

ND not detected less than 0.05 ug/litre

ND+ not detected less than 5 ug/litre

tr trace less than 0.1 ug/litre

* approximate response of standard not determined

NOTES



Date Sampled: 88 03 03

WCWR0004

Date Analyzed: 88 03 12

Samples MY10-0206 to 209/4

ELMIRA UniRoyal GROUND WATER STUDY - MONITOR WELL

Compound	My10	1A-87 after 200L (800ml) -0206	1A-87 after 400L (800ml) -0207	1B-87 after 22L (800ml) -0208	1C-87 after 12L (800ml) -0209
<u>Carboxylic acids:-</u>					
- C8 carboxylic acid					4
- C16 carboxylic acid		15	18		
- phenyl thio acetic acid		50	16		
<u>Unidentified:-</u>					
- unidentified		9	8		-
unidentified		35	14		
unidentified		2	3		
unidentified		2	3		
unidentified			3		
unidentified			0.8		
unidentified		43	29		
unidentified		36	6	5	
unidentified		15		3	
unidentified		15	10		
unidentified		21	12		
unidentified		3			
unidentified		36	42		
unidentified		42	11		
unidentified		180	200		
unidentified		14	16		
unidentified		13	13		
unidentified		8			
unidentified		12	9		
unidentified		36	48		
unidentified		23	2		
unidentified		41	93	15	

ND - not detected - less than 0.05 ug/litre

ND+ - not detected - less than 5 ug/litre

tr - trace - less than 0.1 ug/litre

~ - approximate - response of standard not determined

NOTES

MINISTRY OF THE ENVIRONMENT
LABORATORY SERVICES BRANCH
DRINKING WATER ORGANICS SECTION
MASS SPECTROMETRY ANALYTICAL REPORT

To: Wally Rozenberg , Hamilton Regional Office
West Central Region

Re: GC/MS Analysis of Elmira - Uniroyal
samples

Submission No: WCWR 0031

MS Reference No.	Other Lab No.	Sample Description
<u>MY18 - 0157 to 161(S)</u>	<u></u>	<u>Ground Water</u>
<u></u>	<u></u>	<u></u>
<u></u>	<u></u>	<u></u>
<u></u>	<u></u>	<u></u>
<u></u>	<u></u>	<u></u>
<u></u>	<u></u>	<u></u>

For additional information contact: Dr. V.Y. Taguchi
(416) 235 - 5904

C.C. H Tosine
L.I.S
Dr. O. Meres3

Volatile organics were analyzed by a purge-and-trap system followed by gas chromatography/mass spectrometry (GC/MS).

The concentrations of the components on the target compound list are quantitative and were calculated relative to external standards and the internal standards bromochloromethane and 1,3-dichlorobutane.

The concentrations of all other components found are semi-quantitative and were calculated relative to the internal standard 1,3-dichlorobutane.

Extractable organics were determined in the following manner:

The sample was partitioned into base/neutral (B/N) and acid fractions and extracted with methylene chloride.

The concentrated extracts were analyzed by gas chromatography/mass spectrometry (GC/MS).

The concentrations of the components found are semi-quantitative and were calculated relative to the internal standard d_{10} phenanthrene.

The analytical data are presented
in the attached tables.

Reference:

LIS Submission No: WCWR0031

Date of Analysis: 38 05 19

V.Y. Taguchi
V.Y. Taguchi, Ph.D.



Ontario

Ministry
of the
EnvironmentVOLATILE
ORGANIC

Components Found & Their Concentration in ug/L

Page 1 of 4

Date Sampled: 88 04 27

WC WR 0031

Date Analyzed: 88 05 09

Samples MY18 - 0157 to 161 (S)

ELMIRA / UNIROVAL

GROUNDWATER

Compound	FS# MY18	1A - 87 (10 mL) - 0157	1B - 87 (10 mL) - 0158	1C - 87 (100 mL) - 0159	2A - 87 (100 mL) - 0160	S - 65 (5 mL) - 0161
Methylene Chloride		ND (10)	ND (10)	ND (1.0)	ND (1.0)	ND (20)
1,1-Dichloroethylene		ND (0.5)	ND (0.5)	tr	ND	ND (1)
I.S. Bromochloromethane		✓	✓	✓	✓	✓
1,1-Dichloroethane		1.1	1.3	ND	ND	ND (1)
Chloroform		ND (5)	ND (5)	ND (0.5)	ND (0.5)	ND (10)
1,2-Dichloroethane		ND (0.5)	ND (0.5)	ND	ND	ND (1)
1,1,1-Trichloroethane		ND (0.5)	ND (0.5)	ND	ND	ND (1)
Carbontetrachloride		ND (0.5)	ND (0.5)	ND	ND	ND (1)
Dichlorobromomethane		ND (0.5)	ND (0.5)	ND	ND	ND (1)
1,2-Dichloropropane		0.6	ND (0.5)	ND	ND	ND (1)
Benzene		70	130	0.2	0.2	7
Trichloroethylene		1.6	2.4	ND	ND	ND (1)
1,1,2-Trichloroethane		1.7	ND (0.5)	ND	ND	ND (1)
Chlorodibromomethane		ND (0.5)	ND (0.5)	ND	ND	ND (1)
1,2-Dibromoethane		ND (0.5)	ND (0.5)	ND	ND	ND (1)
Bromoform		ND (0.5)	ND (0.5)	ND	ND	ND (1)
I.S. 1,3-Dichlorobutane		✓	✓	✓	✓	✓
Tetrachloroethylene		ND (0.5)	ND (0.5)	ND	ND	ND (1)
Toluene		1.5	49	0.5	0.2	ND (1)
1,1,2,2-Tetrachloroethane		ND (0.5)	ND (0.5)	ND	ND	ND (1)
Chlorobenzene		29	78	ND	ND	78
Ethylbenzene		ND (0.5)	ND (0.5)	ND	tr	ND (1)
m-Xylene		ND (0.5)	ND (0.5)	tr	0.3	1.
o-Xylene		ND (0.5)	ND (0.5)	ND	0.1	ND (1)
1,2-Dichlorobenzene		ND (0.5)	ND (0.5)	ND	ND	ND (1)

ND (#) - not detected - less than # ug/Litre

ND - not detected - less 0.05 ug/litre

ND1 - not detected - less than 1 ug/litre

tr - trace - less than 0.1 ug/litre



Date Sampled: 88 04 27

Date Analyzed: 88 05 13

Samples My18-0157 to 1615

WCWR 0031

ELMIRA / UNIROVAL

GROUND WATER

Compound	FS# My18	1A - 87 (600/6 ml) - 0157	1B - 87 (600/6 ml) - 0158	1C - 87 (600/6 ml) - 0159	2A - 87 (600/6 ml) - 0160	5 - 65 (600/6 ml) - 0161
<u>Nitrogen containing Compounds:-</u>						
- N-nitrosoethylamine		4				
- tetramethyl urea		28				
- 4-ethyl morpholine		52				
- N-(4-formylphenyl)acetamide		22				
- nitrosobenzene			23			
- aniline			4800			
- nitrobenzene			8300			
- 1-methyl-2-nitrobenzene			7			
- N,N-diethyl-3-methylbenzamide			27			
- diphenyl diazene			4			
- azoxybenzene			8			
- hexahydroquinolinone						4
<u>Nitrogen and Sulfur containing Compounds:-</u>						
- isothiocyanatobenzene		6				
- benzothiazole		13	2			
- 2-(3H)-benzothiazolone		130	120			1
- 2-mercaptobenzothiazole		9				
- carboxin		62	16			
<u>Ketones:-</u>						
- methyl cyclohexenone		4				
- tetramethyl octadienone		2	2			1
- 3-hydroxy-3-methyl-2-heptanone			1			

(600/6 ml) \equiv 600 ml extracted / 6 ml analysed.

ND - not detected - less than 0.05 ug/litre

NDT - not detected - less than 5 ug/litre

tr - trace - less than 0.1 ug/litre

* - approximate response of standard not determined



Date Sampled: 88 04 27

Date Analyzed: 88 05 13

Samples MY18-0157 to 161 (5)

WCWR 0031

ELMIRA / UNIROVAL

GROUND WATER

Compound	FS# My18	1A - 87 (600/6ml) - 0157	1B - 87 (600/6ml) - 0158	1C - 87 (600/6ml) - 0159	2A - 87 (600/6ml) - 0160	5 - 65 (600/6ml) - 0161
Miscellaneous :-						
- C ₁₀ carboxylic acid		4				
- miscellaneous carboxylic acids		30 ³				
- 2-ethyl-4-methyl-1,3-dioxane		4				30
- 2,5-dimethyl-1,4-dioxane		11	3			
- miscellaneous hydrocarbons			13	3 ³	4 ³	7
- a C ₄ alcohol		6				
- a C ₆ alcohol						1
- a C ₈ alcohol						2
- 2,5-diethyl tetrahydrofuran						32
- sulfur						4
- 1,1,2,2-tetramethoxy ethane		1				
Unidentified		350 ¹⁵	81 ⁷			1

(600/6 ml) \equiv 600 ml extracted / 6 ml analysed

ND — not detected — less than 0.05 ug/litre

ND† — not detected — less than 5 ug/litre

tr — trace — less than 0.1 ug/litre

* — approximate response of standard not determined

286 (10/84) Superscript # — number of compounds

APPENDIX "B"

Excerpted tables and figures from:

Terraqua Investigations Ltd.

Hydrogeological Investigation for a Proposed Water
Supply Well, for Sulco Chemicals, Elmira, Ontario Draft
Report
December, 1988

- Site plan illustrating Sulco property and location of Sulco OW-1 and PW-1
- Borehole logs for Sulco wells PW-1 and OW-1
- Water quality results for September, 1988 sampling during aquifer testing



TERRAQUA INVESTIGATIONS LTD.

41 PRINCESS STREET, EAST, WATERLOO, ONTARIO N2J 2H6
(519) 888-7892 FAX (519) 888-6006

HYDROGEOLOGICAL INVESTIGATION
FOR A PROPOSED
WATER SUPPLY WELL

Prepared For:

Sulco Chemicals
ELMIRA, Ontario

by

TERRAQUA INVESTIGATIONS LTD.

R.J. Blackport
S.L. Schellenberg

Reference No. TA8882

December 1988

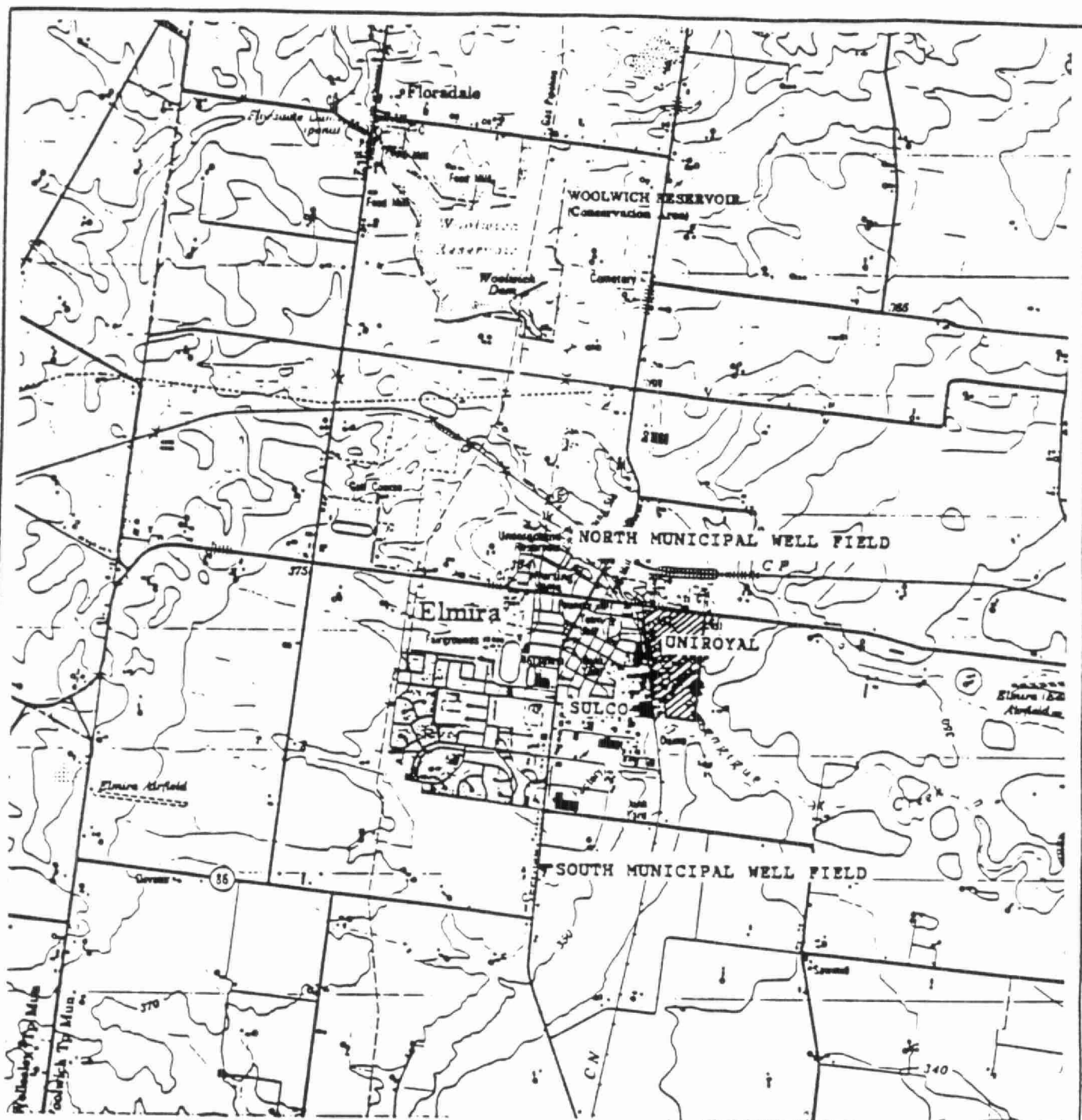


Figure 1. Site Setting

Scale

1:50,000

PROJECT TA8882



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LEGEND

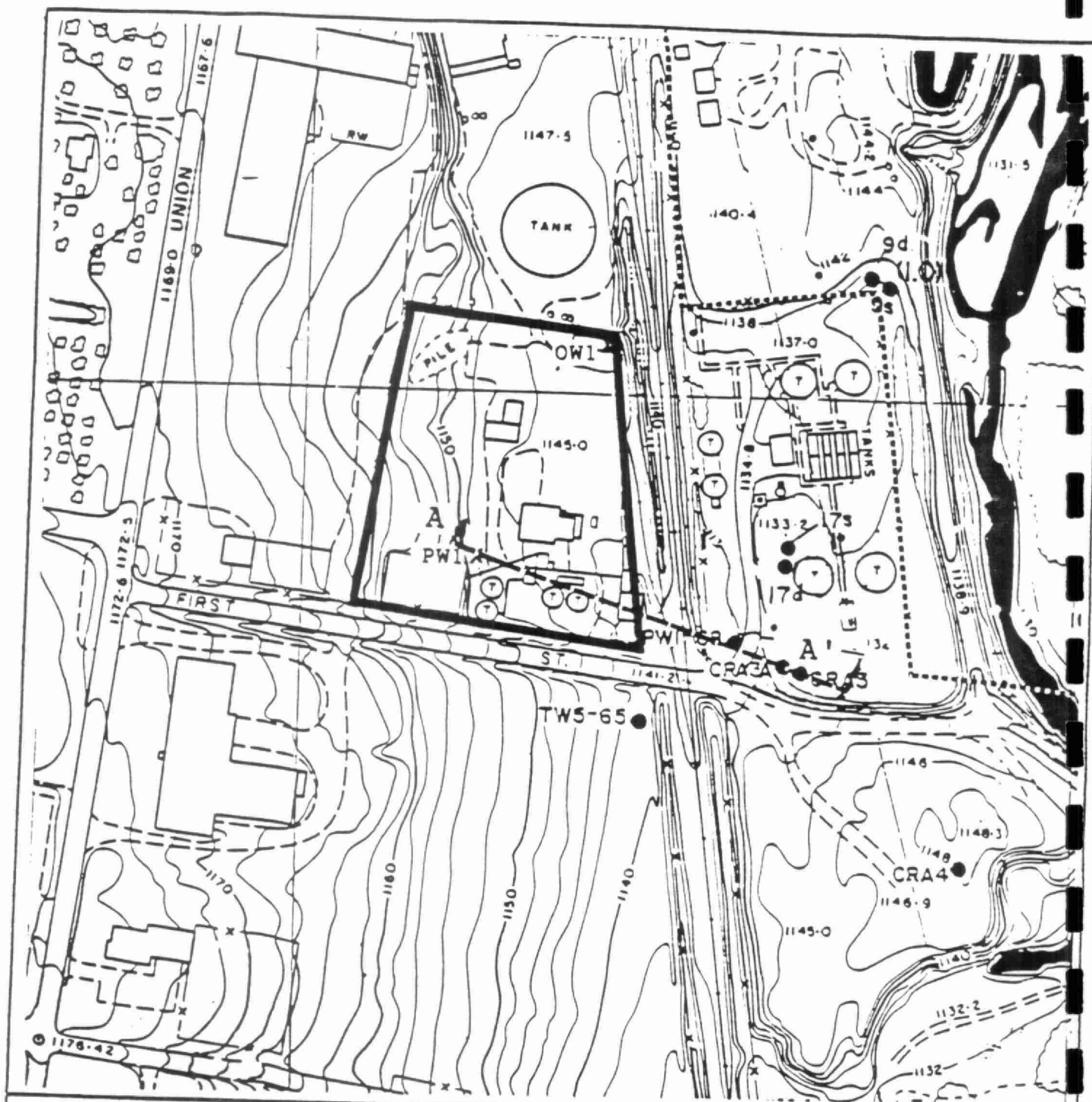


Figure 2. Detailed Site Map with Wells and Geological Cross-section Location

Scale

1:2400

PROJECT TA8882



TERRACUA INVESTIGATIONS LTD.

LEGEND

- Site Boundary
- Site Well
- A — A' Geological Cross-section
- Uniroyal Property Boundary

BOREHOLE NO. OW1 continued

PROJECT TA8882

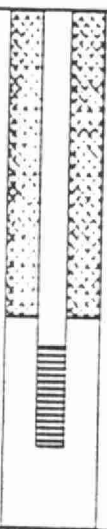
GEOLOGIST SLS

CLIENT SULCO CHEMICALS

DATE August 30, 1988

BOREHOLE TYPE Mud Rotary

SAMPLE TYPE Cuttings

DEPTH metres	DESCRIPTION	SAMPLES		GROUND WATER MONITORS
		NO	TYPE	
13	continued			continued
14	GRAVEL and SAND - fine gravel, coarse sand - clean		C	
15				
16			C	
17				
18			C	
19	CLAYEY SILT TILL with Sand and gravel		C	BOREHOLE TERMINATED
20				
21				
22				
23				
24				

BOREHOLE NO. OW1

PROJECT TA8882

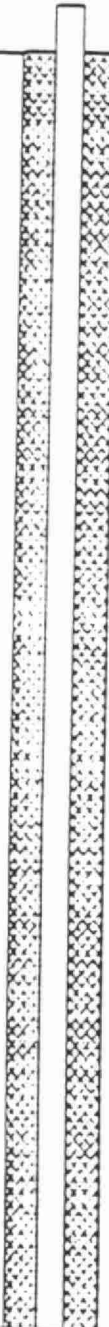
GEOLOGIST SLS

CLIENT SULCO CHEMICALS

DATE August 30, 1988

BOREHOLE TYPE Mud Rotary

SAMPLE TYPE Cuttings

DEPTH metres	DESCRIPTION	SAMPLES		GROUND WATER MONITORS
		NO	TYPE	
0	SAND and GRAVEL - fine to coarse sand, fine gravel, few fines			
1				
2			C	
3			C	
4				
5			C	
6			C	
7				
8			C	
9			C	
10	SAND, Interbedded with SILT and CLAY, trace gravel - silt and clay layers with some fine to coarse sand and trace gravel, medium cohesion			
11			C	
12				
13				

SAMPLE TYPE Cuttings

[illegible]

PROJECT TA8882

GEOLOGIST SLS

CLIENT SULCO CHEMICALS

DATE August 22, 1988

BOREHOLE TYPE Mud Rotary

SAMPLE TYPE Cuttings

DEPTH metres	DESCRIPTION	SAMPLES		GROUND WATER MONITORS
		NO	TYPE	
0				
1	SAND and GRAVEL - medium to coarse sand, some fines			
2	- fine gravel		C	
3			C	
4				
5			C	
6				
7	- sand layer from 6.7 m. to 7.6 m.		C	
8	SAND interbedded with SILT and CLAY, trace gravel		C	
9	- silt and clay layers with some fine to coarse sand and trace gravel, medium cohesion		C	
10	- sand layer of very fine to fine well sorted sand.		C	
11			C	
12			C	
13	SAND and GRAVEL - coarse sand, some gravel trace of fines			

CHEMICAL ANALYSIS FROM PW1, SULCO (pg.3 of 3)

TEST DESCRIPTION	1 HOUR	25.3 HOURS	46 HOURS
o-Xylene (ug/L)	<0.05<W	0.40<T	1.65
1,1,2,2Tetrachloroethane (ug/L)	<0.05<W	<0.05<W	<0.05<W
1,4-Dichlorobenzene (ug/L)	<0.1<W	<0.1<W	<0.1<W
1,3-Dichlorobenzene (ug/L)	<0.1<W	<0.1<W	<0.1<W
1,2-Dichlorobenzene (ug/L)	<0.05<W	<0.05<W	<0.05<W
2,4,6,Trichlorophenol (ng/L)	<50.0<W	55.0	100.0
245 Trichlorophenol (ng/L)	<50.0<W	<50.0<W	80.0
234 Trichlorophenol (ng/L)	<100.0<W	<100.0<W	<100.0<W
2356 Tetrachlorophenol (ng/L)	<50.0<W	<50.0<W	<50.0<W
2345 Tetrachlorophenol (ng/L)	<50.0<W	<50.0<W	<50.0<W
Pentachlorophenol (ng/L)	<50.0<W	<50.0<W	<50.0<W
Dicamba (ng/L)	<100.0<W	<100.0<W	<100.0<W
24D Propionic Acid (ng/L)	<100.0<W	<100.0<W	<100.0<W
24-Dichlorophenoxyacetic (ng/L)	<100.0<W	<100.0<W	<100.0<W
Silvex (ng/L)	<50.0<W	<50.0<W	<50.0<W
245-Trichlorophenoxyacet (ng/L)	<50.0<W	60.0	60.0
24-Dichlorophenoxybutyrc (ng/L)	<200.0<W	<200.0<W	<200.0<W
Picloram	!NP	!NP	!NP

<T - a measurable trace amount: interpret with caution
 <W - no measurable response (zero): <reported value
 UIN - unreliable: indeterminate interference
 UCR - data unreliable: could not confirm by reanalysis
 APL - additional peak, large, not priority pollutant
 UCS - unreliable: contamination suspected
 RMP - p and m-xylene not seperated
 !NP - no data: no appropriate procedure available

CHEMICAL ANALYSIS FROM PW1, SULCO (pg.2 of 3)

TEST DESCRIPTION, UNITS	1 HOUR	25.3 HOURS	46 HOURS
1,1-Dichloroethylene (ug/L)	15.0	11.8	12.2
Dichloromethane (ug/L)	<0.5<W	<0.5<W	<0.5<W
TRS-1, 2-Dichloroethylene (ug/L)	0.3<T	0.3<T	0.2,T
1,1-Dichloroethane (ug/L)	26.5	29.6	26.0
Chloroform (ug/L)	0.9<T APL	0.2<T APL	0.2<T APL
1,1,1-Trichloroethane (ug/L)	7.44	7.74	6.68
1,2-Dichloroethane (ug/L)	<0.05<W	<0.05<W	<0.05<W
Carbontetrachloride (ug/L)	<0.2<W	<0.2<W	<0.2<W
Benzene (ug/L)	3.55	4.70	8.05
1,2-Dichloropropane (ug/L)	<0.05<W	<0.05<W	<0.05<W
Trichloroethylene (ug/L)	7.5	6.5	6.7
Dichlorobromomethane (ug/L)	<0.05<W	<0.05<W	<0.05<W
Toluene (ug/L)	0.15<T UCS	0.35<T	1.10
1,1,2-Trichloroethane (ug/L)	<0.05<W	<0.05<W	<0.05<W
Chlorodibromomethane (ug/L)	<0.1<W	<0.1<W	<0.1<W
Tetrachloroethylene (ug/L)	<0.05<W	<0.05<W	<0.05<W
Chlorobenzene (ug/L)	64.0	77.5	125.0
Total Trihalomethanes (ug/L)	0.90<T	<0.50<W	<0.50<W
Ethylbenzene (ug/L)	<0.05<W	0.80	2.25
Ethylene Dibromide (ug/L)	<0.05<W	<0.05<W	<0.05<W
p-xylene (ug/L)	<0.1<W	<0.1<W RMP	<0.1<W RMP
m-Xylene (ug/L)	<0.1<W	<0.3<T	2.0
Bromoform (ug/L)	<0.2<W	<0.2<W	<0.2<W

CHEMICAL ANALYSIS FROM PW1, SULCO (pg.1 of 3)

TEST DESCRIPTION, UNITS	1 HOUR	25.3 HOURS	46 HOURS
Conductivity (umho/cm at 25°C)	3450.0	3390.0	3360.0
Hardness (mg/L as CaCO ₃)	1500.0	1470.0	1480.0
Calcium (mg/L as Ca)	369.0	357.0	366.0
Magnesium (mg/L as Mg)	141.00	139.00	138.00
Sodium (mg/L as Na)	269.0	255.0	247.0
Potassium (mg/L as K)	5.75	5.85	5.85
Alkalinity (mg/L as CaCO ₃)	369.5	375.5	379.5
pH	7.91	7.84	7.73
Chloride (mg/L as Cl ⁻)	439.00	416.00	421.00
Sulphate (mg/L as SO ₄)	1014.00	998.60	975.90
Nitr'n, Total Kjeld (mg/L as N)	1.80	1.90	2.10
Ammonium Totl (mg/L as N)	1.60	1.70	1.75
Nitrates Totl (mg/L as N)	0.90	1.00	0.80
Nitrite (mg/L as N)	0.020<T	0.020<T	0.020<T
Phenolics (ug/L as Phenol)	12.6 UIN	16.4	49.6 UCR
Ion Balance Calculation (%)	2.526	1.282	2.015
Total Positive Ions (MEQ)	41.98	40.61	40.64
Total Negative Ions (MEQ)	40.94	40.10	39.83
Est. Dissolved Solids (mg/L)	2469.0	2407.0	2391.0
Estimated Conductivity (umho/cm at 25°C)	4524.0	4411.0	4395.0
Iron (mg/L as Fe)	6.12	5.88	3.98
Manganese (mg/L as Mn)	0.450	0.450	0.330

Relative Mobility (Terraqua, 1987)

Aromatics > Halogenated Aliphatics > Chlorophenolics
[10² ug/L(6)] [10¹ ug/L(3)] [10² ng/L(3)]

The concentrations of the aromatics and the chlorophenolics increased with time, but the concentration of the halogenated aliphatics remained fairly constant. Phenolics and several halogenated aliphatics (1,1 - dichloroethylene, 1,1 - dichloroethane, 1,1,1 - trichloroethane) and aromatics (benzene, trichloroethylene, and chlorobenzene) were present in all 3 water samples taken 1, 25.3 and 46 hours into the pumping test. The concentration of phenol, and the aromatics, benzene and chlorobenzene, increased with time. Ethylbenzene, also an aromatic, appeared in the second sample and its concentration increased in the third sample. The aromatics, toluene, m-xylene, and o-xylene appeared at relatively low concentrations in the third sample, and the chlorophenolics, 2,4,6 trichlorophenol and 245 trichlorophenol, and the herbicide, 245-trichlorophenoxyacet, which were below detection limit in the first sample, appeared in the second or third sample.

The organics constituents present in the first water sample collected from PW1 indicates organic contaminant plume from Uniroyal is already under the Sulco site. In addition, as mentioned earlier the observed drawdown at OW1 (0.5 metres) is on the same scale as water level fluctuations seen in the area over 2 day periods, indicating that the pumping of PW1 at low rates is not expected to influence the water levels in the Middle Aquifer under the Uniroyal site. As a result there will be little change



APPENDIX "C"

Excerpts from:

Morrison-Beatty Ltd.

Report on Groundwater Impact Assessment Lined Waste Pits
RPE-4 and RPE-5, Uniroyal Chemical, Elmira
April, 1989

- Figure 1 - Location Map
- Figure 3 - Groundwater Flow - Lined Pit Area
- Figure 4 - Groundwater Flow - Middle Aquifer

**REPORT ON
GROUNDWATER IMPACT ASSESSMENT
LINED WASTE PITS RPE 4 & RPE 5**

UNIROYAL CHEMICAL, ELMIRA

MORRISON BEATTY LIMITED

**4500 Dixie Road
Mississauga, Ontario
(416) 624-9308**

**APRIL 1989
PROJECT NO. 225-862-LP 1**

**D.R. DUNCAN, C.E.T.
B.W. BEATTY, P.ENG.**



LOCATION

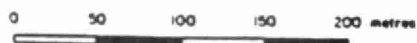
- | —x—x— | UNIROYAL | PROPERTY | BOUNDARY |
|-------|----------|-------------|----------------|
| + 3s | UNIROYAL | OBSERVATION | WELL |
| + PM | UNIROYAL | PUMPING | WELL |
| o RW | RECHARGE | WELL - 1984 | WPCP EXPANSION |
| o | OFF-SITE | OBSERVATION | WELL |

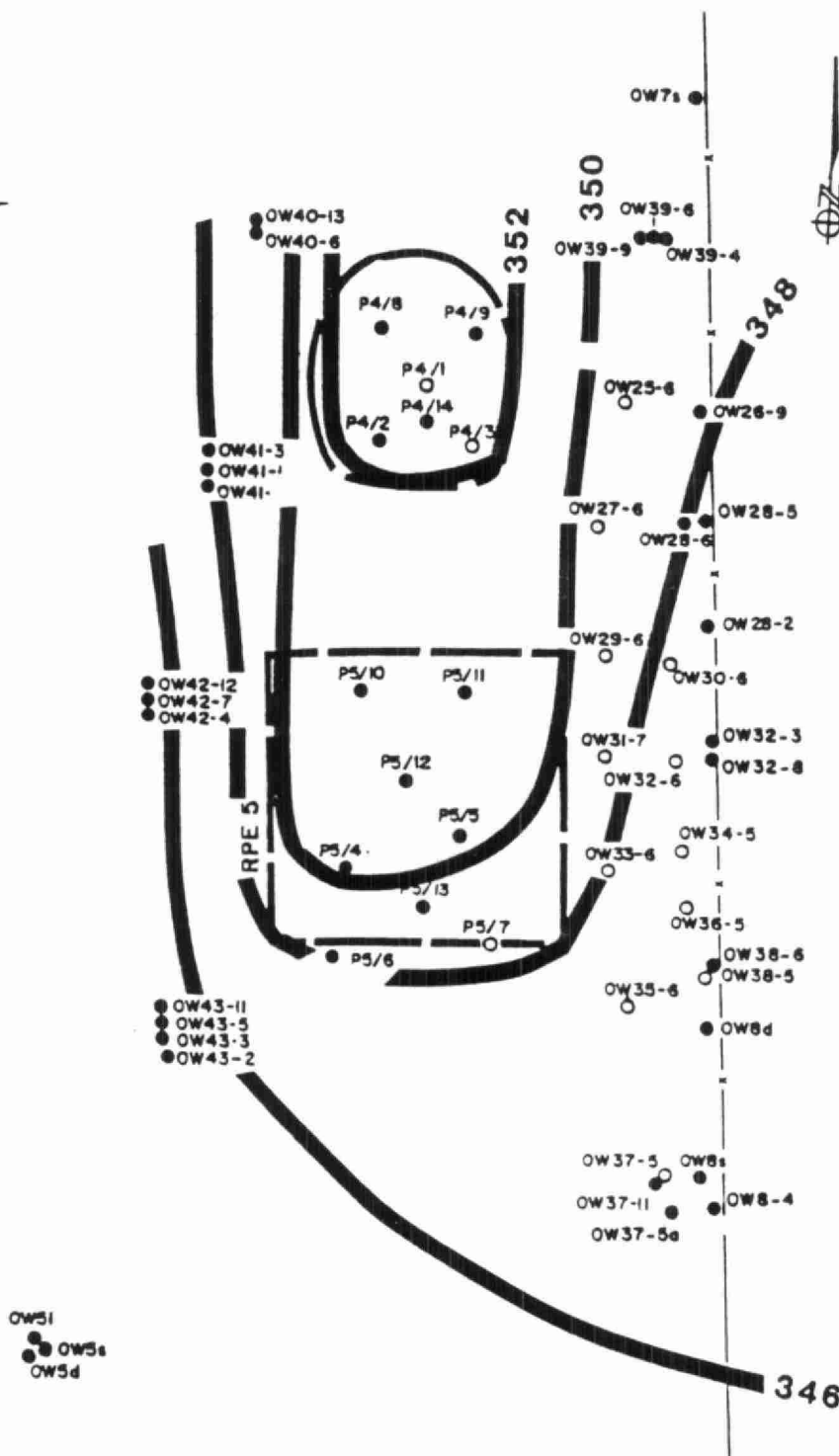
PROJECT NO. 225-862

APRIL, 1989

morrison bently limited
consulting engineers and hydrogeologists

1





LEGEND

- OW26-9 OBSERVATION WELL
- P5-12 WELL IN LINED PIT
- WELL DESTROYED IN DRUM EXCAVATION
- — — — — EDGE OF LINED PIT
- — — — — WATER LEVELS - JULY 4, 1988
- 346 CONTOUR INTERVAL = 2m

HYDROGEOLOGIC PROGRAM
Uniroyal Chemical Limited, Elmira

GROUNDWATER FLOW -
LINED PIT AREA

PROJECT NO. 225-862

APRIL, 1989



morrison beatty limited
consulting engineers and hydrogeologists



LEGEND

- OBSERVATION WELLS AND WELL NESTS (Selected)
- RECHARGE WELLS - 1984 WPCP EXPANSION (General Locations)
- 334 ——— PIEZOMETRIC CONTOUR (CI = 0.25 m) INTERPRETED FROM RESULTS OF JULY 1987 WATER LEVEL SURVEY

SOURCE 1980 Aerial Photography from the Regional Municipality of Waterloo

UNIROYAL CHEMICAL LTD
Elmira, Ontario

GROUNDWATER FLOW -
MIDDLE AQUIFER

PROJECT NO. 225-862

APRIL, 1989



morrison beatty limited
consulting engineers and hydrogeologists

APPENDIX "D"

- Technical Memorandum R. Hillier to D. Ireland,
December 8, 1989, Re: Elmira Well Contamination,
Status Report and Overview



December 8, 1989

119 King St W
12th Floor - Box 2112
Hamilton Ontario
L8N 3Z9
416/521-7640

119, rue King ouest
12^e étage - Casier 211
Hamilton (Ontario)
L8N 3Z9
416 521-7640

TECHNICAL MEMORANDUM

TO: D. Ireland P. Eng
District Officer
Cambridge District

FROM: R. Hillier
Project Hydrogeologist
Technical Support

RE: Elmira Well Contamination
Status Report and Overview

Introduction

Since the discovery of n-nitrosodimethylamine in the Elmira municipal wells E7 and E9 staff of the Technical Support Section have performed sampling of the majority of the monitoring wells in the southern portion of the town. Most of these results are now available. Results from domestic wells (sampled by Abatement staff) and monitoring wells sampled by Morrison Beatty Ltd. for Uniroyal monitoring wells are also available.

Hydrogeological reports and existing water quality analysis for the area have also been studied in order to better understand the site.

The purpose of this memo is to update you on the progress being made in the hydrogeological investigation and to provide you with an interpretation of the results. To that end I am also providing you with my professional opinion as to what I consider to be the most likely source, or source area for the NDMA and identifying what steps should be taken for confirmation.

Sampling Program

The attached table summarizes the monitoring wells and domestic wells which have been sampled since the discovery, and the results obtained. Water is obtained from these wells by a variety of methods including nitrogen gas driven check valve pumps, bailers, inertia (Waterra type) pumps, and electric submersible.

Analytical Results

NDMA has to date been detected in 4 monitoring wells, municipal

wells E7 and E9, and 5 private domestic water wells. Analysis of water from the Sulco Ltd. well are not complete at this time, nor are the analysis from monitoring wells on the Varnicolor Ltd. The available results have been plotted on the attached figure.

The highest NDMA concentration to date, 170 ppb, was found in monitor MOE-1c located approximately 150 m west of the Uniroyal property. Monitor MOE 1b which is at the same location but deeper in the municipal aquifer complex reported 50 ppb. Monitor 56-25 located south west of Uniroyal exhibited 18 ppb of NDMA. Monitor CRA 3 located immediately south of Uniroyal and the Elmira WPCP had concentrations of ²⁰>30 ppb.

Two domestic wells (Soehner and Hackert) reported concentrations as >40ppb.

To date N-nitrosodimethylamine has not been detected in groundwater on the Uniroyal property. This includes the 3 wells most recently sampled, 106d, 104d, and 18d. NDMA was not detected in eight samples taken by Canviro Ltd. in 1988 from monitoring wells installed around the former Uniroyal treatment lagoons. It should be pointed out that these samples were run without an NDMA standard and that these samples contained high concentrations of numerous other organic compounds.

Previous Analytical Results for NDMA

NDMA was detected in samples from monitoring well CRA 3 obtained June 6, 1988. Its concentration was approximately 32 ppb. It appears that this was the first time NDMA was ever detected in groundwater in the Elmira area.

None of the study reports for the area have ever identified DMNA as a potential problem due undoubtedly to its apparent absence in analytical reporting. These include reports by Morrison Beatty Ltd (for Uniroyal), Terraqua Ltd. (for MOE), and Canviro Ltd. (joint funding including Environment Canada through DSS).

Previous Significant Analytical Results

Monitors MOE 1a, 1b, 1c, and 1d were installed in 1987. They were sampled twice in 1988 and analyzed for Base Neutral Extractables. Monitors MOE 1b and 1c exhibited markedly elevated concentrations of aniline, and nitrobenzene which are accepted Uniroyal indicators. NDMA was not detected at this time however it is possible that the aniline and nitrobenzene concentrations were sufficiently high to mask the presence of NDMA. I have asked the lab to review these results with this in mind.

Discussion

Although NDMA has not been detected on the Uniroyal property proper, its detection in wells MOE 1b and 1c, 56-25, and CRA-3

strongly suggests that Uniroyal contains the source area for this contaminant. These wells all tap the municipal aquifer complex and are downgradient from the Uniroyal site.

The data to date suggests that the actual flow path from the site to the south well field is not simple. NDMA has been detected in CRA-3 and 56-25, located south and south west of Uniroyal; however, several locations between these monitors and wells E7 and E9 have revealed no NDMA. These include domestic wells at Reich, Martrins, Bauman, and a recently installed monitoring well 57-33 located near the water tower between First Street and Howard Street. Borehole logs for 57-33 suggest that the aquifer in this area is quite silty and may therefore exhibit slower groundwater velocities.

The aniline and nitrobenzene detected at MOE 1b and 1c must come from Uniroyal. These have been detected in quantity on-site and the monitors are downgradient from it. NDMA would travel much faster in groundwater than either of these compounds.

Groundwater flow from the site in the municipal aquifer is toward the west due to municipal well pumping and then tend either north or south depending on the proportion of pumping from each well field (Canviro Phase I report). The distribution of NDMA in the domestic wells supports this scenario in that higher concentrations were detected near the Arthur and Oriole intersection and declining values occurred in wells to the west. Unfortunately there are presently no monitors within the serviced portion of the town between location MOE 1 and the contaminated domestic wells to confirm this. Current data suggest a flow path which leaves the site between Uniroyal wells 19d and 18d passes through MOE 1 then bends south towards wells E7 and E9. This flow path is consistent with previous groundwater flow mapping and the computer modelling done by Canviro.

A number of other potential sources were evaluated including industrial and natural sources. Comments on these follow.

Varnicolor is downgradient from monitor 56-25. Given the pumping history of both well fields it would be virtually impossible to get NDMA from Varnicolor to any of the domestic wells which have been contaminated. This holds true for all of the industrial park area.

The former Bolander Park Landfill and the First Street Landfill have also been evaluated as potential sources. The Bolander Park Landfill is clearly out of the cone of influence of the south well field due to distance and its proximity to the north well field.

The First Street Landfill was also considered as a potential source; however several monitoring wells and domestic wells which lie between the former landfill and the well field exhibited no NDMA. In addition it would not be possible for NDMA to migrate

to the affected domestic wells from this landfill given the municipal pumping.

Agricultural practices near the municipal wells as well as a barn fire were also considered as potential sources. There is a large thickness of low permeability till in this area and this would minimize contaminant infiltration to the aquifer. In addition NDMA reportedly rapidly degrades in sunlight. This potential source should be discounted.

Conclusions

The Uniroyal property is the likely source area for NDMA although as indicated earlier it has not been detected on-site to date.

The former Bolander Park and First Street Landfills, and the southern industrial park are not potential source areas. The distribution of contaminated wells, both private and municipal preclude this possibility.

Recommendations

1. The focus of any further study should be on the Uniroyal property. This should include a modest drilling program to install monitoring wells adjacent the Uniroyal property between existing monitors 19d and 18d.
2. Selected on-site monitors should be resampled and analysed giving special attention to the presence of NDMA.
3. The on-site area southeast of monitor 19d should be investigated in detail and if monitors exist they should also be sampled.
4. Monitoring wells should be established within the town of Elmira to further confirm flow path from MOE 1 to the south well field. One of these should be located near the intersection of Arthur and First Streets, and the other near the intersection of South Street East and King Street.



Robert Hillier
Project Hydrogeologist

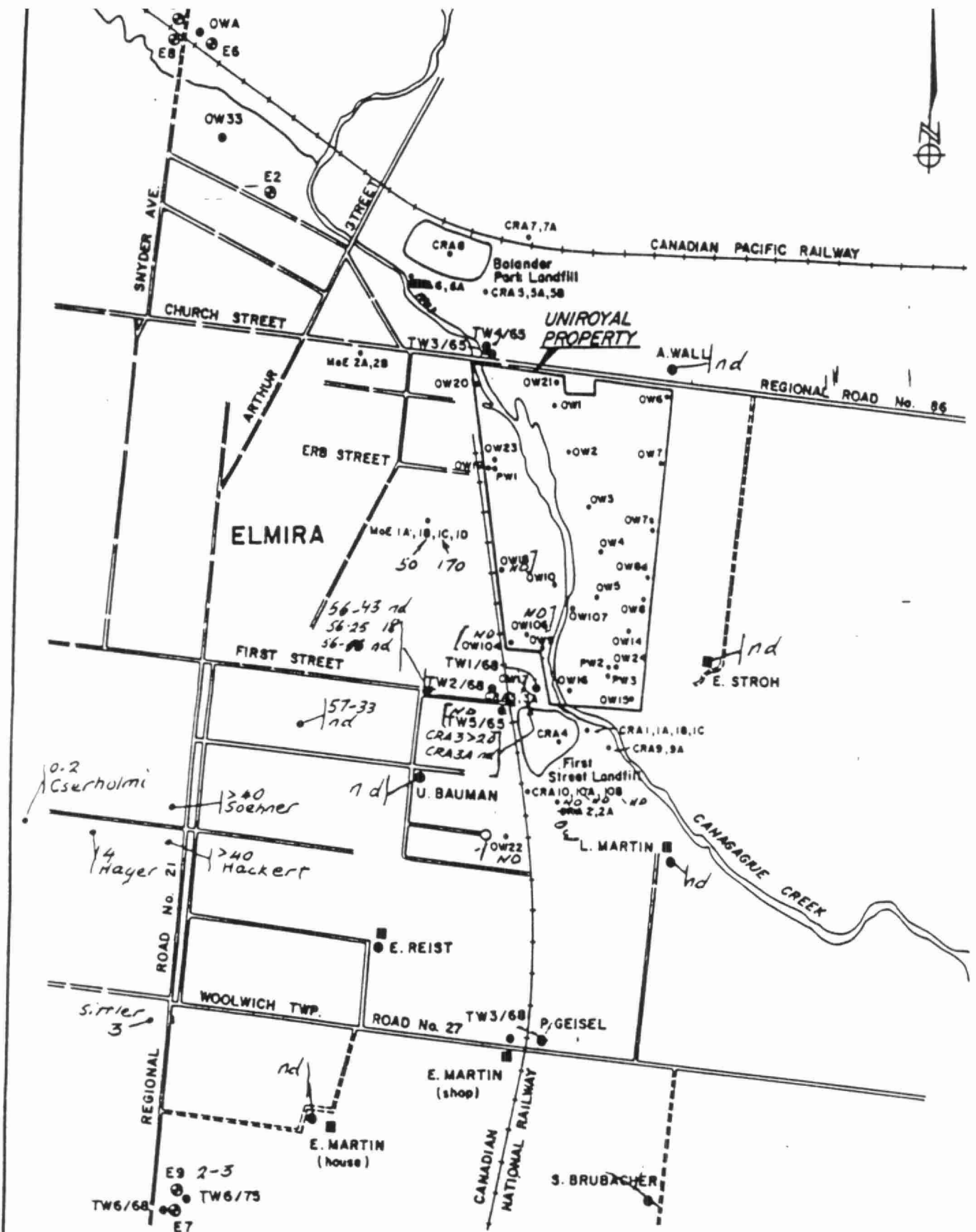
cc: Stan Irwin

Groundwater Sampling Results
Elmira, Ontario

Location _	Date d/m/y	N-nitrosodimethylamine ppb
<u>Monitoring Wells</u>		
CRA 3/83	13-11-89	>20
10B-84	15-11-89	N.D. (0.05)
10-84	15-11-89	N.D. (0.05)
10A-84	15-11-89	N.D. (0.1)
CRA 3A/83	17-11-89	N.D. (0.05)
6/75	17-11-89	N.D. (0.1)
56-16	(13 to 17)-11-89	N.D. (2.0)
56-25	(13 to 17)-11-89	18
56-43	(13 to 17)-11-89	N.D. (2.0)
57-33	(13 to 17)-11-89	N.D. (2.0)
OW 22d		
OW 18d	(13 to 17)-11-89	N.D. (2.0)
OW 104d	(13 to 17)-11-89	N.D. (2.0)
OW 106d	(13 to 17)-11-89	N.D. (2.0)
MOE 1b	(13 to 17)-11-89	50 (2.0)
MOE 1c	(13 to 17)-11-89	170 (2.0)

Location _	Date d/m/y	N-nitrosodimethylamine ppb
<u>Domestic Wells</u>		
E. Martin (rural)	11-11-89	N.D. (0.2)
E. Reist (rural)	11-11-89	N.D. (0.2)
L. Martin (rural)	11-11-89	N.D. (0.2)
Cressman (326 Arthur)	15-11-89	N.D. (0.05)
J. Kraach (320 Arthur)	15-11-89	N.D. (0.05)
G. Martin (362 Arthur)	15-11-89	N.D. (0.05)
G. Bartholemen (358 Arthur)	15-11-89	N.D. (0.05)
Horizons Restaurant	15-11-89	N.D. (0.05)
Dub-L-E-Service	15-11-89	N.D. (0.05)
A. Wall	15-11-89	N.D. (0.05)
E. Stroh	15-11-89	N.D. (0.05)
F. Hager 19 Oriole	15-11-89	40 4 124
F. Hackert 260 Arthur	15-11-89	Ra > 40
Everhope Farms	23-11-89	N.D. (0.2)
A. Kern 120 Barnswallow	27-11-89	N.D. (0.5)
F. Hager 29 Oriole	28-11-89	3
E. Cserholmi 35 Oriole	28-11-89	0.2
W. Sittler 316 Arthur	28-11-89	3
W. Hilker 330 Arthur	28-11-89	N.D. (0.1)

Location	Date d/m/y	N-nitrosodimethylamine ppb
Harder 374 Arthur	28-11-89	N.D. (0.1)
C. Cressman 326 Arthur	29-11-89	N.D. (0.1)
D. Twesnick 334 Arthur	29-11-89	N.D. (0.1)
D. Martin 338 Arthur	29-11-89	N.D. (0.1)
HRTWD Furniture 346 Arthur	29-11-89	N.D. (0.1)
C. Wideman 366 Arthur	29-11-89	N.D. (0.1)
H. Soehner 250 Arthur	29-11-89	>40
E. Hackett 260 Arthur	01-12-89	>40
E. Bauman 105 Howard	01-12-89	N.D. (0.1)
J. Lewis 354 Arthur	01-12-89	N.D. (0.1)



0 200 400 600 800 metres
SCALE 1:10000

- UNIROYAL OBSERVATION WELL NEST
- ⊙ MUNICIPAL SUPPLY WELL
- MUNICIPAL OBSERVATION WELL
- PRIVATE WELL (drilled)
- PRIVATE WELL (dug)

HYDROGEOLOGIC PROGRAM
Uniroyal Chemical Ltd., Elmira

WELL LOCATIONS

PROJECT No. 225-841



morrison beatty limited
consulting engineers and hydrogeologists

A-

APPENDIX "E"

- Analytical results for NDMA for Elmira monitoring wells, domestic wells, and November 30, 1989 samples of Elmira WPCP and Uniroyal Effluents

Location	Date d/m/y	N-nitrosodimethylamine ppb
<u>Monitoring Wells</u>		
CRA 3/83 _	14-11-89	>20
5-65	13-11-89	N.D. (0.05)
10B-84	15-11-89	N.D. (0.05)
10-84	15-11-89	N.D. (0.05)
10A-84	15-11-89	N.D. (0.1)
CRA 3A/83	17-11-89	N.D. (0.05)
6/75	17-11-89	N.D. (0.1)
56-16	09-11-89	N.D. (2.0)
56-25	09-11-89	18
56-43	09-11-89	N.D. (2.0)
57-33	09-11-89	N.D. (2.0)
OW 22d	14-11-89	N.D. (2.0)
OW 18d	14-11-89	N.D. (2.0)
OW 104d	14-11-89	N.D. (2.0)
OW 106d	14-11-89	N.D. (2.0)
MOE 1b	14-11-89	50 (2.0)
MOE 1c	14-11-89	170 (2.0)
Sulco-5 min.	04-12-89	5.3
Sulco-100 min.	04-12-89	5.9
56-25	05-12-89	7.6
56-43	05-12-89	N.D. (0.1)
57-32	05-12-89	3.4
Varnicolor M2-2	06-12-89	N.D. (1.0)
Varnicolor M2-3	06-12-89	N.D. (0.5)
6/75	08-12-89	0.7
19d	11-12-89	>300

Location	Date d/m/y	N-nitrosodimethylamine ppb
106d	11-12-89	N.D. (5.0)
18d	11-12-89	A-1500
55-5	11-12-89	300
MOE-1c	11-12-89	N.D. (2.0)
Sulco OW-1	12-12-89	33
MOE-1a	12-12-89	94
MOE-1b	12-12-89	17
104d	12-12-89	4.1
18d	19-12-89	>10
55-5	19-12-89	>20
6-17	19-12-89	N.D. (0.010)
19d	19-12-89	>90

Location	Date d/m/y	N-nitrosodimethylamine ppb
<u>Domestic Wells</u>		
E. Martin (rural)	11-11-89	N.D. (0.2)
E. Reist (rural)	11-11-89	N.D. (0.2)
L. Martin (rural)	11-11-89	N.D. (0.2)
Cressman (326 Arthur)	15-11-89	N.D. (0.05)
J. Kraach (320 Arthur)	15-11-89	N.D. (0.05)
G. Martin (362 Arthur)	15-11-89	N.D. (0.05)
G. Bartholemen (358 Arthur)	15-11-89	N.D. (0.05)
Horizons Restaurant	15-11-89	N.D. (0.05)
Dub-L-E-Service	15-11-89	N.D. (0.05)
A. Wall	15-11-89	N.D. (0.05)
E. Stroh	15-11-89	N.D. (0.05)
F. Hager 19 Oriole	15-11-89	4
F. Hackert 260 Arthur	15-11-89	>40
Everhope Farms	23-11-89	N.D. (0.2)
A. Kern 120 Barnswallow	27-11-89	N.D. (0.5)
F. Hager 29 Oriole	28-11-89	3
E. Cserholmi 35 Oriole	28-11-89	0.2
W. Sittler 316 Arthur	28-11-89	3
W. Hilker 330 Arthur	28-11-89	N.D. (0.1)

Location	Date d/m/y	N-nitrosodimethylamine ppb
Harder 374 Arthur	28-11-89	N.D. (0.1)
C. Cressman 326 Arthur	29-11-89	N.D. (0.1)
D. Twesnick 334 Arthur	29-11-89	N.D. (0.1)
D. Martin 338 Arthur	29-11-89	N.D. (0.1)
HRTWD Furniture 346 Arthur	29-11-89	N.D. (0.1)
C. Wideman 366 Arthur	29-11-89	N.D. (0.1)
H. Soehner 250 Arthur	29-11-89	>40
E. Hackert 260 Arthur	01-12-89	>40
E. Bauman 105 Howard	01-12-89	N.D. (0.1)
J. Lewis 354 Arthur	01-12-89	N.D. (0.1)
E. Cserhalmi 35 Oriole	05-12-89	0.4
Yanchus 308 Arthur	05-12-89	5.4
H. Sittler 316 Arthur	05-12-89	6.0
E. Sauder 383 Arthur	08-12-89	N.D. (0.05)
C. Szunk 384 Arthur	08-12-89	N.D. (0.05)
Life Skills 158 Church	08-12-89	N.D. (0.05)
ARC Industries 146 Church	08-12-89	N.D. (0.05)
Downie Reg.Rd. 86E	08-12-89	N.D. (0.05)

Location	Date d/m/y	N-nitrosodimethylamine ppb
E. Reist, dug (rural)	19-12-89	N.D. (0.010)
L. Martin, barn (rural)	19-12-89	N.D. (0.010)
E. Martin, drilled (rural)	19-12-89	N.D. (0.010)
E. Reist, drilled (rural)	19-12-89	0.066
L. Martin, dug (rural)	19-12-89	N.D. (0.010)
A. Wall (rural)	19-12-89	N.D. (0.010)
E. Stroh (rural)	19-12-89	N.D. (0.010)

ADDITIONAL DATA

Location	Date d/m/y	N-nitrosodimethylamine ppb
STP - Town raw -	30-11-89 1245 hr.	N.D. (0.5)
STP - Uniroyal Ray	30-11-89 1245 hr.	2000
STP - Effluent	30-11-89 1245 hr.	50
STP - Sludge	30-11-89 1245 hr.	0.9
STP - Supernatant	30-11-89 1245 hr.	N.D. (3.0)

APPENDIX "F"

- Various Water Quality Analysis including Surface Water and Uniroyal Effluents
 - NDMA Data Table for November 30, 1989 to January 20, 1989
 - Parameters exceeding the Laboratory Detection Limit, Elmira STP

REVISED: 17-01-90 1145/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
1989

ANALYSIS RESULTS IN PPB (ug/l)
} = SHARED WELL
ND(XX) = NON DETECTABLE 'XX' LIMIT
*** = ANALYSIS NOT DONE FOR PARAMETER
A = APPROXIMATE RESULT
NA = NOT AVAILABLE -DIRTY SAMPLE
(?) = QUESTIONABLE RESULTS

SAMPLE DATE	WELL DESCRIPTION	T Y P E	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	CYCLOHEXY LAMINE RAW	CYCLOHEXY LAMINE TREATED	DATE RESULTS CONFIRMED	SAMPLED BY
	MOE INTERIM GUIDELINE (ppb)			0.014		550		
SEPT 19	E9	M	3	4	6	3	NOV 9	MOE
	E5	M	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 9	MOE
NOV 9	E9	M	40	40	ND(0.5)	ND(0.5)	NOV 11	MOE
	MON. WELL 56-16		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL 56-25		18	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL 56-43		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL 57-33		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
NOV 11	E9	M	>7.0	>7.0	1	ND(0.5)	NOV 13	MOE
	E7	M	1.6	1.5	ND(0.5)	ND(0.5)	NOV 13	MOE
	E7	M	2	3.3			NOV 13	R.M.O.W.
	E2	M	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
	E5	M	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
	E6	M	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
	E8	M	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
	HACKERT -264 ARTHUR	D	**	1.5	ND(0.5)	ND(0.5)	NOV 13	MOE
	E. MARTIN	P	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
	E.REIST	P	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
	L. MARTIN	P	ND(0.2)	ND(0.2)	ND(0.5)	ND(0.5)	NOV 13	MOE
NOV 13	MON. WELL 5/65		ND(0.05)	***	***	***	DEC 6	MOE-TECH.
NOV 14	MON. WELL - CRA 3/83		>20	***	***	***	DEC 6	MOE-TECH
	GORDS SERV. 52 CHURCH	D	***	ND(.05)	***	ND(0.5)	NOV 17	MOE
	HACKERT- 264 ARTHUR	D	***	0.3	***	ND(0.5)	NOV 17	MOE
	ST. JACOBS - STONE CROCK	D	***	0.1	***	ND(0.5)	NOV 17	MOE
	MON. WELL 0W22D		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL 0W18D		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL 0W104D		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL 0W106D		ND(2.0)	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL MOE-18		50	***	***	***	DEC 6	MORRISON/BEATTY
	MON. WELL MOE-1C		170	***	***	***	DEC 6	MORRISON/BEATTY
NOV 15	CRESSMAN 326 ARTHUR	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE
	J. KRAACH 320 ARTHUR	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE
	G. MARTIN 362 ARTHUR	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE
	G BARTHOLOMEW 358 ARTHUR	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE
	HORIZONS RESTURANT	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE
	DUB-L-E SERVICE CENTRE	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE

REVISED: 17-01-90 1145/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
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*** = ANALYSIS NOT DONE FOR PARAMETER
A = APPROXIMATE RESULT
NA = NOT AVAILABLE -DIRTY SAMPLE
(?) = QUESTIONABLE RESULTS

SAMPLE DATE	WELL DESCRIPTION	T Y P E	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	CYCLOHEXY LAMINE RAW	CYCLOHEXY LAMINE TREATED	DATE RESULTS CONFIRMED	SAMPLED BY:
	MOE INTERIM GUIDELINE (ppb)			0.014		550		
	A. WALL	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE-TECH.
	E. STROH	P	ND(.05)	***	ND(0.5)	***	NOV 17	MOE-TECH.
	MON. WELL 10B-84		ND(0.05)	***	***	***	DEC 6	MOE-TECH.
	MON. WELL 10-84		ND(0.05)	***	***	***	DEC 6	MOE-TECH.
	MON. WELL 10A-84		ND(0.1)	***	***	***	DEC 6	MOE-TECH.
NOV 17	MON. WELL 3A-83		ND(0.05)	***	***	***		MOE-TECH.
	MON. WELL 6/75		ND(0.1)	***	***	***		MOE-TECH.
NOV 18	ELMIRA - HYDRANT	D	***	0.1	***	0.1	NOV 20	MOE
	ELMIRA - HYDRANT	D	***	0.1	***	0.1	NOV 20	MOE
	ST. JACOBS WELL #1	M	ND(.05)	***	N.D	***	NOV 20	MOE
	ST. JACOBS WELL #2	M	ND(.05)	***	ND	***	NOV 20	MOE
	ST. JACOBS - FIRE HALL	D	***	0.3	***	0.3	NOV 20	MOE
	ST. JACOBS - WATER ST.	D	***	0.1	***	0.1	NOV 20	MOE
NOV 22	ST. JACOBS - ST. CROCK	D	***	ND(.05)	***	ND(1.0)	NOV 25	MOE
	ST. JACOBS -WATER ST.- F.H.	D	***	.05	***	ND(1.0)	NOV 25	MOE
	ELMIRA - BONNIE CRES	D	***	ND(.05)	***	ND(1.0)	NOV 25	MOE
	GORD'S SERVICE -52 CHURCH	D	***	ND(.05)	***	ND(1.0)	NOV 25	MPE
	TANK - HOWARD ST.	D	***	ND(.05)	***	ND(1.0)	NOV 25	MOE
	TANK - DUNKE ST. RESERV.	D	***	ND(.05)	***	ND(1.0)	NOV 25	MOE
	D. HACKERT 264 ARTHUR ST.	D	***	ND(.05)	***	ND(1.0)	NOV 25	MOE
	F. HAGER 19 ORIOLE PKWY	P	4	***	ND(1.0)	***	NOV 26	MOE
	E. HACKERT 260 ARTHUR	P	>40	***	ND(1.0)	***	NOV 26	MOE
	E9 BEFORE ULTRA VIOLET	M	3	***	ND(1.0)	***	NOV 26	MOE
	E9 AFTER ULTRA VIOLET	M	2	***	ND(1.0)	***	NOV 26	MOE
	PUMP OIL E9	M	ND(80)	***	***	***	NOV 26	MOE
	PUMP OIL E7	M	ND(80)	***	***	***	NOV 26	MOE
	PUMP OIL E8	M	ND(80)	***	***	***	NOV 26	MOE
	E9 INNER CASING	M	7	***	ND(0.5)	***	NOV 26	MOE
	E9 OUTER CASING	M	ND(0.2)	***	ND(0.5)	***	NOV 26	MOE
	MONARCH STOCK OIL 8874	M	ND(80)	***	***	***	NOV 26	MOE
NOV 23	EVERHOPE FARMS	P	ND(0.2)	***	***	***	NOV 28	MOE
	HOWARD ST.-STORM WATER		ND(0.2)	***	***	***	NOV 28	MOE
	HOWARD ST - DITCH SEDIMENT		ND(2.0)	***	***	***	DEC 17	MOE
	VARNICOLOR-SOIL SAMPLE		ND(2.0)	***	***	***	DEC 17	MOE

REVISED: 17-01-90 1145/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
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SAMPLE DATE	WELL DESCRIPTION	T Y P E	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	CYCLOHEXY LAMINE RAW	CYCLOHEXY LAMINE TREATED	DATE RESULTS CONFIRMED	SAMPLED BY
	MOE INTERIM GUIDELINE (ppb)			0.014		550		
NOV 27	A. KERN 120 BARNSWALLOW	P	ND(0.5)	***	***	***	DEC 17	MOE
NOV 28	F. HAGER 19 ORIOLE	P	3	***	***	***	DEC 3	MOE
	E. CSERHALMI 35 ORIOLE	P	0.2	***	***	***	DEC 3	MOE
	W. SITTLER 316 ARTHUR }		SHARED	***	***	***	DEC 3	MOE
	L. ELLIGSON 312 ARTHUR }	P	3	***	***	***	DEC 3	MOE
	W. HILKER 330 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	HARDER 374 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	HOLTERMAN 376 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
NOV 29	C. CRESSMAN 326 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	D. TWESNICK 334 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	D. MARTIN 338 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	HRTWD. FRNTURE 346 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	C. WIDEMAN 366 ARTHUR	P	ND(0.1)	***	***	***	DEC 3	MOE
	H. SOEHNER 250 ARTHUR }	P	>40	***	***	***	DEC 4	MOE
	M. SMITH 244 ARTHUR }		SHARED	***	***	***	DEC 4	MOE
	PINTAIL DR. -SURFACE WATER		ND(0.1)	***	***	***	DEC 4	MOE
NOV 30	STP - TOWN RAW(E1) -		ND(0.5)	***	***	***	DEC 16	MOE-INSPEC
	STP - UNIROYAL RAW(E2)		2000	***	***	***	DEC 16	MOE-INSPEC
	STP - FINAL EFFLUENT(E3)		50	***	***	***	DEC 16	MOE-INSPEC.
	STP - SLUDGE(E4)-SUPERN.		0.9	***	***	***	DEC 16	MOE-INSPEC.
	STP - SLUDGE(E4)-SOLIDS		ND(3.0)	***	***	***	DEC 16	MOE-INSPEC
DEC 1	E. HACKERT 260 ARTHUR	P	>40	***	***	***	DEC 4	MOE
	E. BAUMAN 105 HOWARD	P	ND(0.1)	***	***	***	DEC 4	MOE
	J. LEWIS 354 ARTHUR	P	ND(0.1)	***	***	***	DEC 4	MOE
DEC 4	SULCO - 5 MIN. PUMPING		5.3	***	***	***	DEC 11	MOE-TECH
	SULCO - 100 MIN PUMPING		5.9	***	***	***	DEC 11	MOE-TECH
DEC 5	E. CSERHALMI 35 ORIOLE	P	0.4	***	***	***	DEC 14	MOE
	YANCHUS 308 ARTHUR	P	5.4	***	***	***	DEC 14	MOE
	H. SITTLER 316 ARTHUR	P	6	***	***	***	DEC 14	MOE
	PUBLIC WORKS YARD	M	ND(0.05)	***	***	***	DEC 14	MOE
	DUNKE RESERVOIR	M	ND(0.05)	***	***	***	DEC 14	MOE
	MON. WELL 56-25		7.6	***	***	***	DEC 11	MOE-TECH.

REVISED: 17-01-90 1145/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
1989

ANALYSIS RESULTS IN PPB (ug/l)
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SAMPLE DATE	WELL DESCRIPTION	T Y P E	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	CYCLOHEXY LAMINE RAW	CYCLOHEXY LAMINE TREATED	DATE RESULTS CONFIRMED	SAMPLED BY:
	MOE INTERIM GUIDELINE (ppb)			0.014		550		
	MON. WELL 56-43		ND(0.1)	***	***	***	DEC 11	MOE-TECH.
	MON. WELL 57-32		3.4	***	***	***	DEC 11	MOE-TECH.
DEC 6	VARNICOLOR - #2-2		ND(1.0)	***	***	***	DEC 11	MOE-TECH.
	VARNICOLOR - #2-3		ND(0.5)	***	***	***	DEC 11	MOE-TECH.
DEC 8	MON. WELL 6-75		0.7	***	***	***	DEC 14	MOE-TECH.
	O. SAUNDER 383 ARTHUR	P	ND(0.05)	***	***	***	DEC 18	MOE
	C. SZMUNK 384 ARTHUR	P	ND(0.05)	***	***	***	DEC 18	MOE
	LIFE SKILLS 158 CHURCH	P	ND(0.05)	***	***	***	DEC 18	MOE
	ARC INDUSTS. 146 CHURCH	P	ND(0.05)	***	***	***	DEC 18	MOE
	DOWNIE REG. ROAD 86 EAST	P	ND(0.05)	***	***	***	DEC 18	MOE
DEC 11	MON. WELL 19D		>300	***	***	***	DEC.17	MOE-TECH.
	MON. WELL 106D		ND((5)	***	***	***	DEC.17	MOE-TECH.
	MON. WELL 18D		A-1500	***	***	***	DEC.17	MOE-TECH.
	MON. WELL 55-5		300	***	***	***	DEC.17	MOE-TECH.
	MON. WELL MOE-1C		ND(2.0)	***	***	***	DEC.17	MOE-TECH.
DEC 12	SULCO DM-1		33	***	***	***	DEC 14	MOE-TECH.
	MOE-1A		94	***	***	***	DEC 14	MOE-TECH.
	MOE-1B		17	***	***	***	DEC 14	MOE-TECH.
	MON. WELL 104D		4.1	***	***	***	DEC 14	MOE-TECH.
DEC 19	CANAGAGIGUE - HWY #86 & ELMIRA		0.015	***	***	***	DEC 31	MOE
	GRAND RIVER - WEST MONTROSE BRIDGE		0.012	***	***	***	DEC 29	MOE
	UNIROYAL CARBON FILT/OUT		>100	***	***	***	DEC 27	MOE
	UNIROYAL CARBON FILT/IN		NA	***	***	***	DEC 27	MOE
	UNIROYAL AREATION INFLOW		NA	***	***	***	DEC 27	MOE
	UNIROYAL SEWAGE TO STP		>300	***	***	***	DEC 27	MOE
	ELMIRA STP - SLUDGE			***	***	***	DEC 29	MOE
	ELMIRA STP - FINAL EFFLUENT		0.87	***	***	***	DEC 29	MOE
	CANAGAGIGUE - FIRST BRIDGE DWN STRM		0.21	***	***	***	DEC 29	MOE
	E. MARTIN -120ft	P	ND(0.0.10)	***	***	***	DEC 27	MOE
	E. REIST - SHOP - 100ft	P	0.066	***	***	***	DEC 27	MOE
	E. REIST - RESID. - 15ft	P	ND(0.010)	***	***	***	DEC 27	MOE
	A. WALL	P	ND(0.010)	***	***	***	DEC 29	MOE
	E. STROH - 18ft	P	ND(0.010)	***	***	***	DEC 29	MOE
	L. MARTIN -DUG	P	ND(0.010)	***	***	***	DEC 27	MOE
	L. MARIN - DRILLED	P	ND(0.010)	***	***	***	DEC 27	MOE

REVISED: 17-01-90 1145/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE

CHRONOLOGICAL HISTORY

1 9 8 9

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	MOE INTERIM GUIDELINE (ppb)			0.014		550		
	MON. WELL 19D		>90	***	***	***	DEC 27	MOE
	MON. WELL 18D		>10	***	***	***	DEC 27	MOE
	MON. WELL OW6-17			***	***	***		MOE
	MON. WELL 55-5		>20	***	***	***	DEC 27	MOE
	WELL K-80 -	M	ND(0.01)	0.012	***	***	DEC 20	MOE
	WELL K-81 -	M	ND(0.01)	0.069	***	***	DEC 20	MOE
	WELL K-82 -	M	ND(0.01)	0.008	***	***	DEC 20	MOE
	GRAND RIVER - FREEPORT BRIDGE		0.017	***	***	***		MOE
	BRANTFORD - WTP	M	0.015	0.013	***	***	DEC 20	MOE
	BRANTFORD - WTP	M	ND(0.010)	0.042	***	***		MOE
	CAYUGA - WTP	M	0.042	0.018	***	***	DEC 20	MOE
DEC 20	BRANTFORD WTP - RAW/INTAKE			***	***	***		MOE
	BRANTFORD WTP - TREATED			***	***	***		MOE
	GRAND RIVER - FREEPORT		ND(0.010)	***	***	***	DEC 27	MOE
	GRAND RIVER -WEST MONTROSE		ND(0.010)	***	***	***	DEC 28	MOE
	CANAGAGIGUE-ELMIRA BRIDGE		ND(0.010)	***	***	***	DEC 28	MOE
	CANAGAGIGUE @ IRON BRIDGE		0.34	***	***	***	DEC 27	MOE
	OHSEWEN WATER WORKS	M	0.033	0.32(?)	***	***	DEC 28	MOE
	ELMIRA STP - EFFLUENT		1.1	***	***	***	DEC 27	MOE
DEC 22	CAYUGA WATER WORKS	M	0.04	0.012	***	***	DEC 24	MOE
	CAYUGA - POST OFFICE	D	***	0.014	***	***	DEC 24	MOE
	CAYUGA - IGA BAKERY	D	***	0.014	***	***	DEC 24	MOE
	TOWN OF HALDIMAN - TOWN OFFICE	D	***	0.04	***	***	DEC 24	MOE
	CAYUGA - TOWN PLAZA	D	***	0.015	***	***	DEC 24	MOE
DEC 27	UNIROYAL DISCHARGE TO STP		>100	***	***	***	DEC 29	MOE
	ELMIRA TOWN TO STP		ND(3.0)	***	***	***	DEC 29	MOE
	ELMIRA STP TO CREEK		ND(2.0)	***	***	***	DEC 29	MOE
	KITCHENER WELL - K80	M	ND(0.010)	***	***	***	DEC 31	MOE
	KITCHENER WELL - K81	M	ND(0.010)	***	***	***	DEC 31	MOE
	KITCHENER WELL - K82	M	ND(0.010)	***	***	***	DEC 31	MOE
	KITCHENER WELL - K73	M	0.019	***	***	***	DEC 31	MOE
	KITCHENER WELL - K74	M	0.012	***	***	***	DEC 31	MOE
	KITCHENER WELL - K75	M	ND(0.010)	***	***	***	DEC 31	MOE
	KITCHENER-FIRE HALL #3	D	ND(0.010)	***	***	***	DEC 31	MOE
	KITCHENER-FIRE HALL #4	D	ND(0.010)	***	***	***	DEC 31	MOE
	CAMBRIDGE-DISTRIBUTION @ STP	D	ND(0.010)	***	***	***	DEC 29	MOE
	RIVER SAMPLE OPPOSITE WELL K81		ND(0.010)	***	***	***	DEC 31	MOE

REVISED: 17-01-90 1145/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
1 9 8 9

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	MOE INTERIM GUIDELINE (ppb)			0.014		550		
	BRANTFORD-WATER TRT. PLANT	M	ND(0.010)	0.013	***	***	DEC 29	MOE
	BRANTFORD-DISTRIBUTION @ STP	D	0.015		***	***	DEC 31	MOE
	CAYUGA - B/G RESTUR.	D	***	0.011	***	***	DEC 28	MOE
	CAYUGA - CORNER VARIETY	D	***	0.012	***	***	DEC 28	MOE
	SIX NATIONS-FIRE HALL	D	0.078		***	***	DEC 29	MOE
DEC 29	UNIROYAL - BUILDING #37		2.5	***	***	***	JAN 5	MOE
	UNIROYAL - BUILDING #13		3	***	***	***	JAN 5	MOE
	UNIROYAL - BUILDING #33		0.034	***	***	***	JAN 5	MOE

REVISED: 2-21-90 1130/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
1990

PM 1:07

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	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
JAN 2, 1990	UNIROYAL BUILDING #18 SUMP	0.17	***	JAN 15	WCWT594	8-18
	UNIROYAL BUILDING #37 SUMP	1.7	***	JAN 29	WCWT594	8-37
	UNIROYAL BUILDING #13 SUMP	2.6	***	JAN 29	WCWT594	8-13
	UNIROYAL BUILDING #33 SUMP	0.097	***	JAN 29	WCWT594	8-33
	ELMIRA STP - FILTER CAKE		***		WCWT595	ES-1
	TOWN SEWAGE - SOUTH PUMPING ST.	ND(0.1)	***	JAN 5	WCWT595	ES-2
	TOWN SEWAGE - PARSHALL FLUME	ND(0.1)	***	JAN 5	WCWT595	ES-3
	UNIROYAL DISCHARGE TO STP	200	***	JAN 9	WCWT595	ES-4
	ELMIRA STP - TREATED LINE SLUDGE		***		WCWT595	ES-5
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.21	JAN 5	WCWT595	ES-6
	BRANTFORD WTP	0.018	0.019	JAN 9		EL-3, EL-9
	BRANTFORD WATER DISTRIBUTION AT STP	***	0.024	JAN 9		EL-6
	BRANTFORD STP FINAL EFFLUENT	***	0.055	JAN 5		EL-7
	CAYUGA WTP		ND(0.010)	JAN 5		EL-1
	CAYUGA AT POST OFFICE	***	0.044	JAN 5		EL-2
	OSHWOKEN - WTP	0.037	0.049	JAN 4		EL-3, EL-4
	OSHWOKEN AT FIRE HALL	***	0.26	JAN 4		EL-5
JAN 3	ELMIRA STP - FILTER CAKE		***		WCWT593	ES-9
	CAMAGAGIGUE - REGIONAL RD #21	ND(0.01)	***	JAN 9	WCWT593	WR-1
	NITH RIVER COUNTY RD. #36 BRIDGE	ND(0.01)	***	JAN 9	WCWT593	BC-3
	GRAND RIVER - NEWPORT ROAD BRIDGE	ND(0.01)	***	JAN 9	WCWT593	BC-2
	GRAND RIVER -HALDM/BRANT COUNTY LINE	ND(0.01)	***	JAN 9	WCWT593	BC-1
JAN 4	ELMIRA STP EFFLUENT - PRE CHLORINATION	6	***	JAN 5	WCWT-592	ST1A
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.24	JAN 5	WCWT-592	ST1
JAN 6	UNIROYAL DISCHARGE TO STP	200	***	JAN 8	WCWT-591	1
	ELMIRA TOWN SOUTH P.S. TO STP	ND(0.1)	***	JAN 8	WCWT-591	2
	ELMIRA TOWN PARSH. FL. TO STP	ND(0.1)	***	JAN 8	WCWT-591	3
	ELMIRA STP FINAL EFFLUENT TO CREEK	0.26	***	JAN 8	WCWT-591	4
JAN 8	UNIROYAL DISCHARGE TO ELMIRA STP	150	***	JAN 11	WC20597	DGR-2
	MISA STATION 0900	0.24	***	JAN 15	WC20597	DGR-4
	MISA STATION 0800	ND(0.030)	***	JAN 29	WC20597	DGR-5
	MISA STATION 0600	0.039	***	JAN 29	WC20597	DGR-6
	MISA STATION 0200	0.011	***	JAN 23	WC20597	DGR-7
	UNIROYAL - VITAVAX WASTE WATER	1.3	***	JAN 11	WC20597	DGR-3
	SHIRT FACTORY CREEK	ND(0.010)	***	JAN 15	WC20598	DGR-8
	ELMIRA - WIDEMAN RESIDENCE	ND(0.010)	***	JAN 15	WC20598	DGR-1

REVISED: 2-21-90 1130/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
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	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
JAN 9	BRANTFORD WATER DISTRIBUTION AT STP	***	0.017	JAN 15	WC15852	DGR-1
	BRANTFORD STP FINAL EFFLUENT	***	0.12			
	SIX NATIONS WATER TREATMENT PLANT	0.013	0.019	JAN 11	WC15853	DGR1, DGR2
	SIX NATIONS PUBLIC WORKS	***	0.4	JAN 11	WC15853	DGR3
	SIX NATIONS FIRE HALL	***	0.12	JAN 11	WC15853	DGR4 -
	CALEDONIA WATER TREATMENT PLANT	ND(0.010)	ND(0.010)	JAN 12	WC16044	FS-001, FS-002
	CAYUGA WATER TREATMENT PLANT	0.078	0.011	JAN 12	WC16044	FS-003, FS-004
	DUNNVILLE WATER TREATMENT PLANT	ND(0.010)	ND(0.010)	JAN 12	WC16044	FS-005, FS-006
JAN 10	ELMIRA STP FINAL EFFLUENT - POST CHLORN.	***	0.4		WC15849	DGR-5
	UNIROYAL DISCHARGE TO ELMIRA STP	180	***		WC15849	DGR-4
JAN 12	ELMIRA STP FINAL EFFLUENT - POST CHLORN.	***	0.8	JAN 15	WC15849	DGR-6
	UNIROYAL DISCHARGE TO ELMIRA STP	190	***	JAN 15	WC15849	DGR-7
	UNIROYAL - VITAVAX WASTE WATER	14	***	JAN 23	WC15849	DGR-1
	UNIROYAL - AERATION INFLUENT	350	***	JAN 15	WC15849	DGR-3
	UNIROYAL - AERATION EFFLUENT	320	***	JAN 15	WC15849	DGR-2
JAN 15	OHSWEKEN WATER TREATMENT PLANT	ND(0.01)	0.06	JAN 17	WC00073	SN-4, SN-1
	OHSWEKEN ADMINISTRATION BUILDING	0.097	***	JAN 17	WC00073	SN-2
	M. JOHNSON - 23 BICENTENNIAL	0.068	***	JAN 17	WC00073	SN-3
	W. HAJAS	ND(0.01)	***	JAN 17	WC00073	SN-5
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.59	JAN 17	WC15856	DGR-1
	UNIROYAL DISCHARGE TO ELMIRA STP	250	***	JAN 19	WC15856	DGR-2
	UNIROYAL - NAUGARD 445 PROCESS WASTE WATER	0.79	***	JAN 23	WC15856	DGR-3
JAN 16	CAYUGA - WTP TREATED	***	ND(0.01)	JAN 18	WC15857	DGR-1
	CAYUGA - POST OFFICE	***	ND(0.01)	JAN 18	WC15857	DGR-2
	BRANTFORD - WTP TREATED	***	ND(0.01)	JAN 18	WC15857	DGR-4
	BRANTFORD - CANAL, RAW SUPPLY	ND(0.01)	***	JAN 18	WC15857	DGR-3
JAN 17	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.62	JAN 19	WC15858	DGR-2
	UNIROYAL DISCHARGE TO ELMIRA STP	250	***	JAN 19	WC15858	DGR-3
	BRANTFORD WATER - 110 BRANTWOOD PARK DR.	***	0.013	JAN 19	WC15859	DGR-1
JAN 19	ELMIRA TOWN DISCHARGE (NORTH) TO STP	0.034	***	JAN 23	WC15860	DGR-1
	ELMIRA TOWN DISCHARGE (SOUTH) TO STP	0.055	***	JAN 23	WC15860	DGR-2
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.1	JAN 23	WC15860	DGR-3
	UNIROYAL DISCHARGE TO ELMIRA STP	210	***	JAN 23	WC15860	DGR-4

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GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
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	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
	UNIROYAL - AERATION INFLUENT				WC15860	DGR-5
	BRANTFORD STP EFFLUENT - POST CHLORN.	**	0.074	JAN 23	WC00075	J-1
	CAYUGA - SECONDARY SCHOOL	**	ND(0.01)	JAN 23	WC00075	J-2
	CAYUGA - JAMES MITCHENER PUBLIC SCHOOL	**	ND(0.01)	JAN 23	WC00075	J-3
JAN 20	UNIROYAL DISCHARGE TO ELMIRA STP	290	***	JAN 23	WC11538	BR-1
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.071	JAN 23	WC11538	BR-2
JAN 22	ELMIRA TOWN NORTH DISCHARGE TO STP	0.072	***	JAN 24	WC15851	DGR-1
	ELMIRA TOWN SOUTH DISCHARGE TO STP	0.067	***	JAN 24	WC15851	DGR-2
	UNIROYAL DISCHARGE TO STP (STATIC SAMPLE)	360	***	JAN 24	WC15851	DG4-4
	ELMIRA STP EFFLUENT - POST CHLORINATION	0.06	***	JAN 24	WC15851	DGR-3
JAN 23	CAYUGA WATER TREATMENT PLANT - RAW	0.018	***	JAN 25	WC16037	K8001
	CAYUGA DISTRIBUTION - POST OFFICE	***	0.013	JAN 25	WC16037	K8002
	OSWEGON WATER TREATMENT PLANT - RAW	0.018	***	JAN 25	WC16037	K8003
	OSWEGON ADMINISTRATION BUILDING	***	0.14	JAN 25	WC16037	K8004
	BRANTFORD WATER TREATMENT PLANT - RAW	ND(0.010)	***	JAN 25	WC16037	K8005
	BRANTFORD - 11 EDGERTON ST.	***	ND(0.01)	JAN 25	WC16037	K8006
	BRANTFORD STP EFFLUENT - POST CHLORIN.	***	0.18	JAN 25	WC16037	K8007
JAN 24	GUELPH CITY DISCHARGE TO STP	0.1	***	JAN 30	WCWT590	GI-1
	GUELPH STP EFFLUENT - POST CHLORN.	***	0.06	JAN 30	WCWT590	GE-2
	ELMIRA STP EFFLUENT - POST CHLORN.	***	0.012	JAN 30	WCWT590	EE-3
	BRANTFORD TOWN DISCHARGE TO STP	0.21	***	JAN 30	WCWT590	BI-4
	BRANTFORD STP EFFLUENT - POST CHLORN.	***	0.22	JAN 30	WCWT590	BE-5
JAN 25	WATERLOO CITY DISCHARGE TO STP	0.043	***	JAN 31	WCWT-589	WI-1
	WATERLOO STP EFFLUENT - POST CHLORIN.	***	0.057	JAN 31	WCWT-589	WE-2
	KITCHENER CITY DISCHARGE TO STP	0.24	***	JAN 31	WCWT-589	KI-3
	KITCHENER STP EFFLUENT - POST CHLORN.	***	0.4	JAN 31	WCWT-589	KE-4
JAN 26	ELMIRA STP EFFLUENT - POST CHLORINATION	***			WC15861	DGR-1
	DUB-L-E SERVICE CENTRE - 390 ARTHUR	ND(0.01)	***	JAN 31	WCWT-588	EL-01
	HORIZONS RESTAURANT	ND(0.01)	***	JAN 31	WCWT-588	EL-02
	HEARTWOOD FURNITURE	ND(0.01)	***	JAN 31	WCWT-588	EL-03
	BILL HILKER - 330 ARTHUR	0.57	***	JAN 31	WCWT-588	EL-04
	LIFE SKILLS SCHOOL - 158 CHURCH	ND(0.01)	***	JAN 31	WCWT-588	EL-05
	ARC INDUSTRIES - 146 CHURCH	ND(0.01)	***	JAN 31	WCWT-588	EL-06

REVISED: 2-21-90 1130/hr

GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
CHRONOLOGICAL HISTORY
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SAMPLE DATE	WELL DESCRIPTION	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	DATE RESULTS CONFIRMED	SUBMISSION NUMBER	SAMPLE NUMBER
	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
JAN 27	UNIROYAL DISCHARGE TO STP -2HR. COMP.	560	***	JAN 31	WC15863	DGR-3
JAN 29	ELMIRA EFFLUENT - POST CHLORINATION	***	0.098	JAN 31	WC15863	DGR-1
	UNIROYAL DISCHARGE TO STP	520	***	JAN 31	WC15863	DGR-2
	BRANTFORD RAW SEWAGE TO STP (COMBINED)	0.092	***	FEB 7	WCWT-587	BI-1
	BRANTFORD STP EFFLUENT - POST CHLORN.	***	0.061	FEB 7	WCWT-587	BE-2
	UNIROYAL - AERATION TANK CONTENTS	850	***	FEB 1	WC-15862	DGR-1
JAN 30	BRANTFORD RAW SEWAGE TO STP (COMBINED)	0.15	***	FEB 7	WCWT-586	BI-1
	BRANTFORD STP EFFLUENT - POST CHLORIN.	***	0.078	FEB 7	WCWT-586	BE-2
	BRANTFORD RAW SEWAGE - DISCHARGE PT. #1	0.059	***	FEB 5	WCWT-586	BI-3
	BRANTFORD RAW SEWAGE - DISCHARGE PT. #2	0.3	***	FEB 5	WCWT-586	BI-4
	BRANTFORD RAW SEWAGE - DISCHARGE PT. #3	0.052	***	FEB 5	WCWT-586	BI-5
	BRANTFORD RAW SEWAGE - DISCHARGE PT. #4	0.013	***	FEB 5	WCWT-586	BI-6
	CONESTOGA COUNTRY CLUB - WELL #2	ND(0.01)	***	FEB 9	WC00076	EO-1
	CONESTOGA COUNTRY CLUB - WELL #1	ND(0.01)	***	FEB 9	WC00076	EO-2
	CONESTOGA COUNTRY CLUB - WELL #3	ND(0.01)	***	FEB 9	WC00076	EO-3
	ELMIRA - BARTHOLOMEW 358 ARTHUR	ND(0.01)	***	FEB 9	WC00076	EO-4
	ELMIRA - G. MARTIN 362 ARTHUR	ND(0.01)	***	FEB 12	WC00076	EO-5
	ELMIRA - HARDER 374 ARTHUR	ND(0.01)	***	FEB 21	WC00076	EO-6
	GUELPH - AIR MON. STATION 6HRS. BLGRND				WCIM003	0001-A
	GUELPH - AIR MON. STATION 6HR. BKGRND				WCIM003	002-B
	ELMIRA ARENA - FIELD BLANK				WCIM003	006-B
JAN 31	UNIROYAL SURGE TANK-SUMP CLEANING EFFLUENT		***		WC-15867	DGR-1
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	3.2	FEB 1	WC-15868	DGR-1
	UNIROYAL DISCHARGE TO STP	2300	***	FEB 1	WC-15868	DG4-2
	ELMIRA - C. WIDEMAN 366 ARTHUR ST	ND(0.01)	***	FEB 21	WC-00077	DJ-1
	ELMIRA - O. SAUNDER 383 ARTHUR ST	ND(0.01)	***	FEB 21	WC-00077	DJ-2
	ELMIRA - C. SZMUNK 364 ARTHUR ST	ND(0.01)	***	FEB 21	WC-00077	DJ-3
	ELMIRA - CRESSMAN 326 ARTHUR ST	ND(0.01)	***	FEB 13	WC-00077	DJ-4
	ELMIRA - C.SHOEMAKER 120 BARNSWALLOW AVE	ND(0.01)	***	FEB 13	WC-00077	DJ-5
	ELMIRA - J. LEWIS 342 ARTHUR ST.	ND(0.01)	***	FEB 21	WC-00077	DJ-6
	CAYUGA WATER TREATMENT PLANT - RAW	ND(0.01)	***	FEB 7	WC-16033	KB-001
	CAYUGA - POST OFFICE	***	ND(0.01)	FEB 7	WC-16033	KB-002
	OHSWEKEN WATER TREATMENT PLANT - RAW	ND(0.01)	***	FEB 5	WC-16033	KB-003
	OHSWEKEN DISTR. - WATER TOWER EFFLUENT	***	0.053	FEB 5	WC-16033	KB-004
	BRANTFORD WATER TREATM. PLANT - RAW		ND(0.01)	FEB 5	WC-16033	KB-005
	BRANTFORD WATER TREAT. PLNT. OUTPUT	***	ND(0.01)	FEB 5	WC-16033	KB-006

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GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
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(?) = QUESTIONABLE RESULTS

SAMPLE DATE	WELL DESCRIPTION	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	DATE RESULTS CONFIRMED	SUBMISSION NUMBER	SAMPLE NUMBER
	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
FEB 1	ELMIRA STP EFFLUENT - POST CHLORINATION	***	2.1	FEB 2	WC-15865	DGR-1
	ELMIRA STP -RAW SEWAGE - MUNICIPAL NORTH	0.046	***	FEB 2	WC-15865	DGR-2
	ELMIRA STP - RAW SEWAGE - MUNICIPAL SOUTH	0.16	***	FEB 2	WC-15865	DGR-3
	UNIROYAL SEWAGE DISCHARGE TO STP	530	***	FEB 2	WC-15865	DGR-4
FEB 2	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.048	FEB 5	WC-15864	DGR-1
	UNIROYAL DISCHARGE TO STP (STATIC)	420	***	FEB 5	WC-15864	DGR-2
	UNIROYAL - BLDG 14 SUMP	1.6	***	FEB 19	WC-15869	UNI-1
	UNIROYAL - BLDG 15 SUMP	0.33	***	FEB 19	WC-15869	UNI-2
	UNIROYAL - BLDG 3 SUMP	1	***	FEB 21	WC-15869	UNI-3
	UNIROYAL - PH BASIN 1	390	***	FEB 20	WC-15869	UNI-4
	UNIROYAL - BALANCE TANK	180	***	FEB 20	WC-15869	UNI-5
	UNIROYAL - EQUALIZATION TANK	410	***	FEB 21	WC-15869	UNI-6
	UNIROYAL - SURGE TANK	640	***	FEB 21	WC-15869	UNI-7
	UNIROYAL - AERATION TANK	1300	***	FEB 21	WC-15869	UNI-8
	ELMIRA STP EFFLUENT - POST CHLORINATION	0.13	***	FEB 7	WC-15869	UNI-9
FEB 5	UNIROYAL DISCHARGE TO STP-SUMP (STATIC)	540	***	FEB 7	WC-15870	DGR-1
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.022	FEB 7	WC-15870	DGR-2
FEB 6	PRESTON STP EFFLUENT - POST CHLORINATION	***			WC-00082	STP-1
	PRESTON STP - DISTILLED WATER		***		WC-00082	STP-2
	GALT STP EFFLUENT - POST CHLORINATION	***			WC-00082	STP-3
	WATERLOO STP EFFLUENT - POST CHLORINATION	***			WC-00082	STP-4
	KITCHENER STP EFFLUENT - POST CHLORINATION	***			WC-00082	STP-5
	GUELPH STP EFFLUENT - POST CHLORINATION	***			WC-00082	STP-6
	GUELPH STP - RAW SEWAGE		***		WC-00082	STP-7
	GALT WATER DISTRIBUTION - GALT STP				WC-00082	STP-8
	ELMIRA STP EFFLUENT - POST CHLORINATION	***			WC-00082	STP-9
	ELMIRA STP - DISTILLED WATER - BLANK		***		WC-00082	STP-10
	CAYUGA WATER TREATMENT PLANT - RAW	0.011	***	FEB 9	WC-16046	KB001
	CAYUGA DISTRIBUTION - POST OFFICE	***	ND(0.01)	FEB 9	WC-16046	KB002
	OSHWOKEN WATER TREATMENT PLANT - RAW	ND(0.01)	***	FEB 12	WC-16046	KB003
	OSHWOKEN DISTRIBUTION - J.C. HILL SCHOOL	***	0.027	FEB 12	WC-16046	KB004
	BRANTFORD WATER TREATMENT PLANT - RAW	ND(0.01)	***	FEB 12	WC-16046	KB005
	BRANTFORD WATER DISTRIBUTION	***	ND(0.01)	FEB 12	WC-16046	KB006
	OSHWOKEN DISTRIBUTION - HEALTH CENTRE	***	0.016	FEB 9	WC-16046	KB007
	GRAND RIVER - WEST MONTROSE BRIDGE	ND(0.01)	***	FEB 9	WCAT-295	RV-1
	CANIGAGIGUE CREEK - REGIONAL ROAD 21	ND(0.01)	***	FEB 9	WCAT-295	RV-2
	CANIGAGIGUE CREEK - IRON BRIDGE	0.11	***	FEB 9	WCAT-295	RV-3

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GRAND RIVER SURVEY - ELMIRA TO DUNNVILLE
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SAMPLE DATE	WELL DESCRIPTION	N-NITROSODI METHYLAMINE RAW	N-NITROSODI METHYLAMINE TREATED	DATE RESULTS CONFIRMED	SUBMISSION NUMBER	SAMPLE NUMBER
	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
	CONESTOGA RIVER - WOOLWICH RD #44	ND(0.01)	***	FEB 9	WCAT-295	RV-4
	GRAND RIVER - HWY #7	ND(0.01)	***	FEB 9	WCAT-295	RV-5
	GRAND RIVER - FREEPORT	ND(0.01)	***	FEB 9	WCAT-295	RV-6
	GRAND RIVER AT BLAIR BRIDGE	ND(0.01)	***	FEB 12	WCAT-295	RV-7
	SPEED RIVER - HWY #8	ND(0.01)	***	FEB 12	WCAT-295	RV-8
		ND(0.01)	***	FEB 13	WCAT-295	RV-9
					WCAT-295	RV-10
	NITH RIVER - HWY 24A, PARIS	ND(0.01)	***	FEB 12	WCAT-295	RV-11
FEB 7	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.011	FEB 12	WC-15872	DGR-1
	UNIROVAL - EQUALIZATION TANK OVERFLOW	420	***	FEB 21	WC-15873	DGR-1
					WCAT-296	RV-1
					WCAT-296	RV-2
					WCAT-296	RV-3
					WCAT-296	RV-4
					WCAT-296	RV-5
					WCAT-296	RV-6
					WCAT-296	RV-7
					WCAT-296	RV-8
					WCAT-296	RV-9
	GRAND RIVER - GLEN MORRIS BRIDGE	ND(0.01)	***	FEB 12	WCAT-296	RV-10
					WCAT-296	RV-11
	GRAND RIVER - BRANTFORD, MARKET ST	ND(0.01)	***	FEB 13	WCAT-296	RV-12
	GRAND RIVER - CALEDONIA, OLD HWY #6	ND(0.01)	***	FEB 13	WCAT-296	RV-13
	GRAND RIVER - YORK	ND(0.01)	***	FEB 13	WCAT-296	RV-14
	TRIP BLANK 4L AMBER - HPLC WATER	ND(0.010)	**	FEB 21	WCAT-296	RV-15
	ELMIRA STP EFFLUENT - POST CHLORINATION	***	ND(0.010)	FEB 21	WCAT-296	RV-16
	WATERLOO STP EFFLUENT-POST CHLORINATION	***	0.029	FEB 20	WCAT-296	RV-17
	KITCHENER STP EFFLUENT-POST CHLORINATION	***	0.37	FEB 20	WCAT-296	RV-18
	PRESTON STP EFFLUENT-POST CHLORINATION	***	0.073	FEB 20	WCAT-296	RV-19
	GALT STP EFFLUENT-POST CHLORINATION	***	0.037	FEB 20	WCAT-296	RV-20
	GUELPH STP EFFLUENT-POST CHLORINATION	***	0.015	FEB 20	WCAT-296	RV-21
	PARIS STP EFFLUENT-POST CHLORINATION	***	ND(0.01)	FEB 20	WCAT-296	RV-22
	BRANTFORD STP EFFLUENT-POST CHLORINATION	***	0.07	FEB 20	WCAT-296	RV-23
	CALEDONIA STP EFFLUENT-POST CHLORINATION	***	0.083	FEB 20	WCAT-296	RV-24
FEB 8	ELMIRA - DUNKE STREET RESERVOIR	ND(0.01)	***	FEB 12	WC-15874	ELMIRA-1
	ELMIRA - REUEL RESIDENCE	0.011	***	FEB 12	WC-15874	ELMIRA-2
	ELMIRA - BAUMANN RESIDENCE	ND(0.01)	***	FEB 13	WCJW-0057	3

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	INTERIM DRINKING WATER GUIDELINE (ppb)		0.014			
FEB 9	ELMIRA STP EFFLUENT - POST CHLORINATION	***	ND(0.01)	FEB 12	WC-15866	DBJ-1
	ELMIRA STP EFFLUENT - DISTILLED WATER	ND(0.01)	***	FEB 12	WC-15866	DBJ-2
FEB 12	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.053	FEB 19	WC-15875	DGR-1
	ELMIRA STP - BLANK SAMPLE	ND(0.01)	***	FEB 19	WC-15875	DGR-2
FEB 14	ELMIRA STP EFFLUENT - POST CHLORINATION	***	0.017	FEB 19	WC-15877	DGR-1
	ELMIRA STP EFFLUENT - DISTILLED WATER	0.012	***	FEB 19	WC-15877	DGR-2
	ELMIRA MONITORING WELL - 58-13	0.13	***	FEB 21	WCJW-0058	
	ELMIRA MONITORING WELL - 58-16	0.32	***	FEB 21	WCJW-0058	
FEB 19	ELMIRA STP EFFLUENT - POST CHLORINATION	***			WC-15878	DGR-1
	ELMIRA STP EFFLUENT - DISTILLED WATER		***		WC-15878	DGR-2
	ELMIRA STP-RAW SEWAGE - MUNICIPAL NORTH		***		WC-15878	DGR-3
	ELMIRA STP - NORTH MUNICIPAL BLANK		***		WC-15878	DGR-4
	ELMIRA STP-RAW SEWAGE - MUNICIPAL SOUTH		***		WC-15878	DGR-5
	ELMIRA STP - SOUTH MUNICIPAL BLANK		***		WC-15878	DGR-6

Uniregal - Elmira Survey

Parameters Exceeding the Laboratory Detection Limit

Station CC - 5 Elmira STP Final Effluent

Compound	Date	Concentration	Units	PWQA/G
	87/02/16	880	ug/l	
	87/11/09	1720	ug/l	
	88/08/11	4400	ug/l	
2,4-DP	88/08/11	1400	ug/l	
2,4,5-T	86/01/14	130	ug/l	-
	86/11/27	130	ug/l	
	87/02/16	100	ug/l	
	87/08/20	130	ug/l	
	87/11/09	265	ug/l	
	88/08/11	350	ug/l	
Bromodichloromethane	86/05/15	1	ug/l	-
Chlorodibromomethane	86/05/15	1	ug/l	-
Chloroform	86/02/04	3	ug/l	-
	86/05/15	4	ug/l	
Trichloroethane	86/02/04	2	ug/l	-
	89/02/23	17	ug/l	
Hexachlorocyclobutadiene	86/01/14	4	ug/l	-
	86/11/27	3	ug/l	
	87/02/16	2	ug/l	
	88/08/11	13	ug/l	
	89/05/24	20	ug/l	
	89/08/02	7	ug/l	
Pentachlorophenol	86/01/14	130	ug/l	500 ug/l
	87/02/16	60	ug/l	
	88/08/11	150	ug/l	
	89/02/23	55	ug/l	
2,3,4-Trichlorophenol	88/08/11	385	ug/l	Tri's 18 ug/l
2,3,4,5-Tetrachlorophenol	88/08/11	325	ug/l	Tetra's 1 ug/l
2,3,5,6-Tetrachlorophenol	88/08/11	240	ug/l	
2,4,5-Trichlorophenol	87/08/20	260	ug/l	
	88/08/11	890	ug/l	

25-Jan-90

Uniroyal - Elmira Survey

Parameters Exceeding the Laboratory Detection Limit

Station CC - 5 Elmira STP Final Effluent

Compound	Date	Concentration	Units	PWQA/G
2,4,6-Trichlorophenol	86/01/14	420	ng/l	See Trl's
	86/05/15	1800	ng/l	
	86/08/21	440	ng/l	
	86/11/27	370	ng/l	
	87/02/16	80	ng/l	
	87/05/21	60	ng/l	
	87/08/20	300	ng/l	
	87/11/09	60	ng/l	
	88/08/11	190	ng/l	
	88/11/23	160	ng/l	
	89/02/23	120	ng/l	

APPENDIX "G"

- Air Emission Information
- Odour Complaint Summary
- Table (1) - Summary of Uniroyal Complaints
- Table (2) - Complaints Listing
- Table (3) - Uniroyal Response to Complaints

TABLE 1
UNIROYAL - COMPLAINTS

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1983												
1984	0	1	5	4	5	10	6	2	4	2	3	0
1985	3	1	5	1	10	10	5	6	4	14	4	1
1986	2	4	2	4	9	3	7	1	2	1	0	0
1987	0	0	0	0	2	2	8	4	4	3	5	2
1988	1	0	1	2	2	1	2	2	1	0	3	0
1989	0	5	2	3	2	8	17	22	12	12	4	4

Total for Year 1983:

1984: 42

1985: 64

1986: 35

1987: 30

1988: 15

1989: 91

---COMPLAINTS 1989

February 16	09:55	Elmira	Elmira
February 26	17:00	Erb St., Elmira	Erb St., Elmira
February 26	21:45	Erb St., Elmira	Erb St., Elmira
February 28	09:30	Erb St., Elmira	Erb St., Elmira
February 28	10:30	Erb St., Elmira	Erb St., Elmira
March 2	22:00	Erb St., Elmira	Erb St., Elmira
March 4	09:55	Erb St., Elmira	Erb St., Elmira
April 21	13:40	First Street East	First Street East
April 21	12:40	Elmira	Elmira
April 27	13:50	Elmira	Elmira
May 18	09:24	First Street East	First Street East
May 29	16:00	Spruce Lane	Spruce Lane
June 7	19:00	Elmira	Elmira
June 8	13:05	First Street E.	First Street E.
June 16	Vegetation	Erb Street	Erb Street
June 20	Car Finish 11/17	Erb Street	Erb Street
June 20	17:45	Water Street	Water Street
June 21	14:55	Erb Street	Erb Street
June 21	3 Days	Queen Street	Queen Street
June 28	10:27	Howard Avenue	Howard Avenue
July 1	-	Erb Street	Sulphur/rubber odours (off/on 1 week)
July 2	11:00	Erb Street	Odours (and yesterday)
July 8	08:39	Erb Street	Rubbery odours
July 9	08:30	Erb Street	Rubbery petroleum odour
July 11	14:07	First Street E.	Smoke/odour
July 18	00:30	Duke Street	Sulphuric acid odour
July 18	22:50	on route home to Finch Pl.	Smoke/chemical/plastic odours
July 18	22:15	Duke Street	Acrid odour
July 20	18:00	Elmira	Strong odour (nauseating)
July 21	10:52	Erb Street	Odours
July 21	18:40	Ratz Street	Terrible odour
July 21	19:00	Barnswallow Dr.	Strong odour
July 21	-	Duke Street	Sweet, chemical odour
July 21	20:45	Ratz Street	Rant odour
July 27	03:00	Queen Street	Odour
July 30	15:50	Duke Street	Sulphurous odour (all afternoon)
July 30	15:15	Erb Street	"VETOX" Odour
Aug 12	09:49	Duke Street	Odours sweet, nauseating
Aug 12	10:00	Water Street	Odours bad
Aug 13	20:19	Bobolink	Odours
Aug 14	19:35	Spruce Lane	Odours
Aug 14	08:15	Center Street	Odours strong
Aug 15	19:00	Victoria St	Brown smoke
Aug 15	02:00	Hwy 86	Strong odour (metallic taste)
Aug 16	16:24	Center Street	Odours
Aug 18	08:35	Duke Street	Odours strong
Aug 18	16:00	Erb Street	Odours chronic 2-3 times/wk
Aug 18	16:00	Queen Street	Odours from wet-ox
Aug 19	18:00	Duke Street	Burning metal type odours
Aug 19	20:18	Ratz Street	Odours rotten like "burning skunks"
Aug 19	09:30	Duke Street	Odours
Aug 22	05:00	Erb Street	Odours
Aug 25	19:21	Erb Street	Odours rubbery
Aug 26	22:50	Duke Street	Acrid chemical type odours
Aug 27	13:53	Ratz Street	Odours
Aug 27	13:46	Ratz Street	Odours off and on all day
Aug 28	09:00	Duke Street	Odours awful
Aug 28	18:00	Duke Street	Strong chemical burning odours
Aug 28	20:00	Park Ave	Regular burning rubber odour
September 12	00:09	Barnswallow & Hwy 86	Wet-Ox odour
September 18	17:56	Centre Street	odour in the afternoon
September 18	20:44	Samuel Street	Intermittent, sweet perfume odours
September 18	21:00	Water Street	Chemical odours
September 19	18:30	Water Street	rubbery smell
September 20	13:30	Centre Street	horrible smell
September 21	19:20	Wightengale Cres.	strong odour
September 21	19:34	Centre Street	herbicide-like odour
September 27	09:30	Erb Street	odour
September 27	09:45	Riverside Drive	terrible odour
September 27	09:55	Victoria Street	terrible odour
September 29	15:15	Barnswallow & Hwy 86	brown smoke
October 9	22:00	First Street	cutting odour
October 9	23:00	Ratz Street	rotten egg odour
October 9	24:00	Duke Street	noise
October 14	08:45	Ernst Street	odour 6 - 7 blocks away
October 14	10:41	Erb Street	burnt styrofoam odour
October 14	10:49	Water Street	strong propane odour
October 20	17:12	Spruce Lane	white smoke burning caller's nose
October 27	23:30	Duke Street	excessive noise
October 28	10:50	Centre Street	strong chemical odour
October 28	10:58	Water Street	rubbery odours
October 28	11:13	Spruce Lane	white fallout
October 30	22:21	Duke Street	excessive noise
November 5	13:00	St. George Street	nauseous, sulphur smell
November 7	14:15	Erb Street	plumes of black smoke
November 13	17:20	Spruce Lane	chemical odours
November 14	17:49	Arthur Street	noxious chemical odour
December 1	23:00	Duke Street, Elmira	excessive noise
December 4	13:30	Central St, Elmira	nauseous odour in house
December 9	10:00	Centre St, Elmira	usual chemical odour
December 13	13:45	Duke St, Elmira	nauseous chemical odour

TABLE 3

UNUSUAL RESPONSE1989

<u>DATE</u>	<u>TIME</u>	<u>LOCATION</u>	<u>WIND DIRECTION</u>	<u>DETAILS</u>
June 5	7:45 pm	Charles St.	SSW @ 10 mph	At 7:35 p.m. a wind change was detected and Bldg. #14 incinerator shut down. Call received during Shutdown Period.
June 13	4:40 pm	Queen St.	East @ 10 mph	Call received about "Wetox" odour. Unit put on standby.
June 21	7:50 pm	Duke St.	SSW @ 6-8 mph	Call received about odour "hanging around all day". No odour present on investigation and caller unable to smell it either.
July 2	1:05 pm	MOE Toronto	East 2 mph	Wetox unit put on standby at 1:15 pm although lagoons were likely source.
July 16	3:55 pm	Water St.	South 2-3 mph	No action taken since odours not present at site of complaint 1 minute after receiving call.
July 18	1:30 pm	MOE Toronto	Unsteady & Changing	A nitrogen regulator malfunction was causing a slight HCl venting. The regulator was shut off stopping the venting and was repaired.
July 19	11:40 am	Finch Ct.	East, Unsteady	No action taken since odour no longer present at site of complaint 10 minutes after receiving call.
July 19	11:10 pm	MOE Toronto	South-West 8 mph	Bldg. #14 incinerator shutdown although no odour detected during investigation of complaint site.
July 21	6:30 pm	Duke St.	South-East 5-10 mph	Wetox unit shutdown at 6:40 pm.
July 21	9:00 pm	MOE Investigator	South-East 1-2 mph	No action taken. Wetox unit already shut down.
July 21	10:30 pm	Ratz St.	South-East	No action taken - odour resembles burning leaves/trash upon investigation.
July 21	11:00 pm	Duke St.	South-East Variable to nil.	No action taken since source discovered to be Municipal Sewage Treatment Plant upon investigation at 11:05 pm.
July 21	11:05 pm	Water St.	North-East 1-2 mph	No odour present upon investigation at site of complaint. Pilot Plant process shutdown in case of odour emission.
July 30	3:45 pm	MOE Toronto	South-East 7-8 mph	Inspection of Plant conducted. 3/4 of plant shut down.
July 30	4:05 pm	MOE Toronto	East 10 mph	Inspection of Plant conducted. Investigated area north of Plant where complaint site indicated. Interviewed residents who claimed there were no odours noticed while being outside for the entire afternoon.
July 31	1:10 pm	Queen St.	South-East 3 mph	Investigation indicated that the suspected source was not in operation. The lagoons were causing slight odours.
July 31	3:48 pm	Duke St.	East 2 mph	No odour present on investigation 5 minutes after call.

1989

TABLE 3(CONT)

DATE	TIME	LOCATION	WIND DIRECTION	DETAILS
Aug.27	2:45 pm	Ratz St. Duke St. MOE Investigator	NE-SE variable @ 10-12 mph	Three calls received by S.A.C. of "sweet smell". Investigator, TRB and Supervisor and complainants could detect no odour at sites. Wetox shutdown since 11:30 am 08/25; Bldg.#44 shutdown since 08/24. No further action taken.
Aug.28	9:10 am	Ratz St.	E to NE @ next to none.	Strong nauseating odour. None present 5 minutes after call. Complainant could not detect either. No further action taken.
	9:20 am	Charles St.	E to SE @ next to none.	Upon immediate investigation, no odour detected by TRB or complainant. During investigation another odour detected from source other than Uniroyal. No further action taken.
	9:00 pm	MOE Toronto	None	Several complaints received. "Burning odour". Rubbish fire at neighbouring property. No further action taken.
Aug.31	5:45 pm	Charles St.	SSW @ 8-10 mph	Bldg.#14 incinerator shutdown. Second call at 6:30 pm from same complainant to indicate problem solved. No further action taken.
Sept.4	12:25 am	Finch Place	East @ 8 mph	"Burnt sulfur smell". No odour detected by investigator or complainant at site or in vicinity of Uniroyal during 45 minute tour. Bldg. #44 put on standby as precaution.
Sept.12	12:30 am	Barnswallow	East @ 5-8 mph	"Strong odour" reported. Investigation conducted at site but no odour detected. Odour detected on route back to Uniroyal. Operations at Bldg.44 adjusted. Return call at 1:15 am indicated complainant noticing decrease in odour.
	12:45 am	MOE Toronto	East @ 5-8 mph	Same as above call.
Sept.12	10:00 am	Barnswallow	N/A	Complainant upset about odour at 12:30 am. Explanation made and information supplied as to odour thresholds and health effects of Mercaptan compounds.
Sept.18	9:30 pm	MOE Toronto	ESE @ 8 mph	"Machine Shop Smell". Investigation yielded no detected odours from Uniroyal. No further action taken.
Sept.19	8:55 pm	MOE Toronto	ESE @ 12 mph	"Acid Rubber Smell" on Water St. investigation found no odours at site. Residents in area "disappeared" when supervisor arrived. Slight odour detected at First St. Bldg. #44 and Wetox put on standby as precaution.
Sept.21	7:40 am	Centre St.	SSW @ 14-15 mph	"Herbicide Smell". Site investigation could not detect odour. Complainant could still smell faintly.
	7:55 pm	MOE Toronto	SSW @ 14-16 mph	Reports from Centre St. and from Nightingale areas. Nightingale call could not describe odour except as "from Uniroyal". Caller would not give name or address to MOE. Investigation indicated odour from source other than Uniroyal for Centre St. call. No further action taken.

TABLE 3 (CONT)

1989

DATE	TIME	LOCATION	WIND DIRECTION	DETAILS
Aug. 1	8:00 am	Not Given	North	Strong odours in person's house from Uniroyal or Martins. No actions required because of Plant being already in shutdown for maintenance.
Aug. 12	10:30 am	5 Calls	East @ 8 mph	Lagoon sludge treatment shutdown because of repeated calls.
	3:40 pm	MOE Toronto	East @ 4 mph	TRB and Supervisor investigated, finding lagoon odours only. Operations already stopped during a.m. calls.
Aug. 13	8:15 pm	Bobolink Place	ENE @ 4 mph	Autoclave discharge started during north wind. Wind change during operation (10-15 min. duration). Shutdown @ 7:50 p.m. Call received @ 8:15 p.m. No further action required.
Aug. 14	8:00 pm	Not Given.	NE	Bldg. #14 Incinerator shutdown at 7:55 p.m. because of wind change. Call received at 8:00 p.m. No further action required.
Aug. 15	7:30 pm	MOE Toronto	SW but unsteady	Bldg. #14 Incinerator shutdown.
Aug. 16	5:12 pm & 6:00 pm	First St. E.	East @ 8-10 mph	Two visits to the complaint. Each indicated the source to be the lagoon sludge project. No further action possible.
Aug. 18	4:30 pm	Queen St.	NW	"Rotten smell" investigated. Wetox Unit put on standby as precaution to appease complainant.
	4:45 pm	Erb St.	NW	"Propane and rotten eggs smell". Wetox being shutdown from previous call already.
	5:00 pm	Queen St.	NW	Wetox Unit already being shutdown.
	8:35 pm	Guardhouse	East @ 2-3 mph	Fire Chief had received complaints from citizens and visited Plant. Lagoons were causing only smells to be found. No further action taken.
Aug. 19	7:15 pm	Centre St.	East @ 2-3 mph	Lagoons found to be causing smell. No further action taken.
	9:15 pm	MOE Toronto	East @ 2-3 mph	Nothing further to be done for Lagoon odour source.
Aug. 22	5:10 am	MOE Toronto	SE @ 1 mph	Investigation found only Lagoon odour. No further action taken.
Aug. 25	10:25 am	Queen St.	East @ 5-10 mph	Site investigation found no odour detectable. Slight Wetox odour noticed on route back to Plant. Wetox shutdown as precaution against "Friday Night" calls. No odour present on review investigation at 1:00 p.m.
	4:45 pm	Duke St.	SSE @ 10 mph	No odour detected during site investigation. Slight diacetyl odour in-plant. Distillation operations stopped. Complainant could not detect odour @ 5:20 p.m.
	7:30 pm	MOE Toronto	SE @ 10 mph	Calls received about "rubber smell". Investigation indicated not from Uniroyal. Bldg. #44 and Wetox already shutdown. No further action taken.

TABLE 3 (CONT)

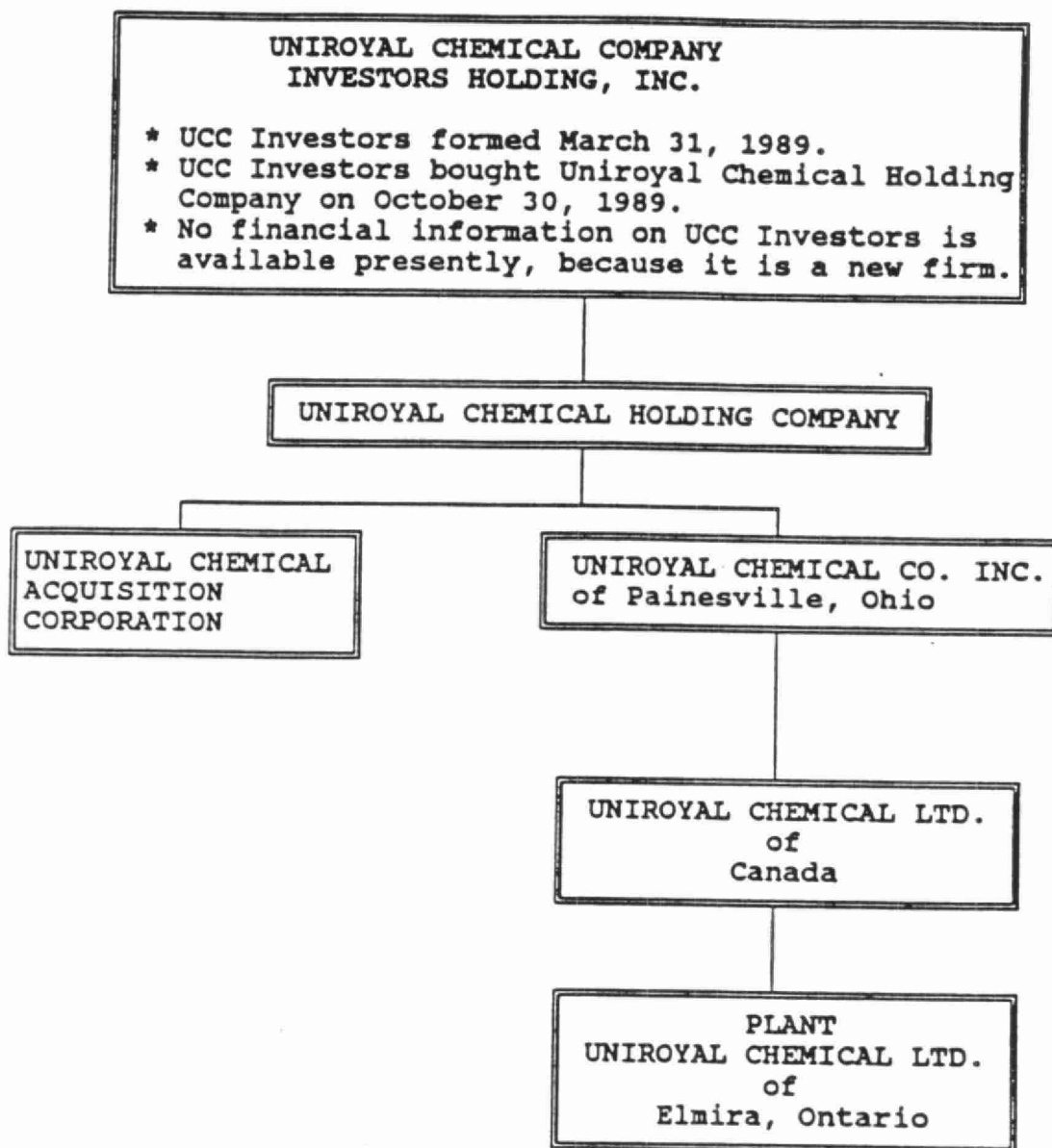
UNIROYAL RESPONSE1989

<u>DATE</u>	<u>TIME</u>	<u>LOCATION</u>	<u>WIND DIRECTION</u>	<u>DETAILS</u>
Sept. 30	10:00 am	MOE Toronto	E - none	Several complaints received at S.A.C. concerning smoke from area of Plant. Not from Uniroyal.
	10:30 am	Centre St.	E - none	"Rubber smell". Not detected during investigation of complaint within 5 minutes of call. Complainant could no longer detect either. Verbal abuse over telephone during complaint to supervisor by complainant.
Oct. 9	11:10 pm	Not Given	None	Choking odour going through her house. Too upset to talk to supervisor. Will call M.O.E. No obvious odours detected in Plant. No location to investigate.
Oct. 14	10:30 am	Park St.W.	East @ 0-5 mph	Bad smelling odour going through property. Wetox put on standby.
	11:00 am	Erb St.	East @ 0-5 mph	Foul smelling odour.
	11:00 am	MOE Toronto	East @ 0-5 mph	Complaints received of odour coming from Plant. Wetox already on standby.
	11:15 am	Erb St.	East @ 0-5 mph	Bad odour going through property.
	7:30 pm	Duke St.	SE @ 15 mph	Odour complaint. Supervisor unable to detect odour at site immediately after receiving call.
	7:35 pm	Duke St.	SE @ 15 mph	No odour detected. Feed rate to carbon kiln reduced as precaution.
Oct. 20	5:45 pm	MOE Toronto	SW @ 15 mph	Complaints received from HNE of Plant "Burning Odour". Bldg. #14 burner shutdown.
	6:15 pm	Charles St.	SW @ 15 mph	Burning smell. Bldg. #14 already shut down.
	6:30 pm	Charles St.	SW @ 15 mph	Oil and gas smell. Upon investigation a breakthrough on an air scrubber was determined. On return to Plant, corrective action was in progress. Report of emission made to SAC.
Oct. 23	3:15 pm	Charles St.	SW @ 10 mph	Investigation of report determined source to be the Bldg. #14 incinerator. Operations stopped pending a wind change.
Oct. 28	12:30 am	Duke St.	East	Noise. No unusual noises identified. Inspection by Regional Police @ 1:00 am found nothing. No action to be taken.
	11:15 am	MOE Toronto (Water St. Spruce St. Centre St.)		Complaints received of odours. No odours detected on Centre and Water Streets. No problems determined in Plant.
Oct. 30	10:20 am	Duke St.	SouthEast	Noise. Same complaint as Oct. 28. No noise detected. No further action taken.

APPENDIX "H"

Uniroyal Chemical Ltd. corporate background and ownership structure

UNIROYAL CHEMICAL LTD.



APPENDIX "I"

Selected Water Quality Analysis reports for monitors 57-33,
18d, and 106d (plus other monitors).



RECEIVED MAR 06 1989

MIN. OF THE ENVIRONMENT
ADMINISTRATIVE SECTION

1993 JAN 30 PM 1:27

Zenon Environmental Inc.

845 Harrington Court, Burlington, Ontario L7N 3P3 Tel.: (416) 639-6320 Telex: 061-8734 Fax: 639-1812
HAMILTON

File No: AN 898079
Work No: A 2466

March 2, 1989

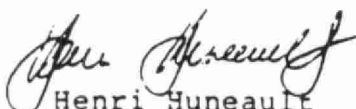
Ross Duncan
Morrison & Beatty
4500 Dixie Road
Unit 12 A
Mississauga, Ontario
L4W 1V7

Dear Ross:

Enclosed, please find the EPA 624 and 625 priority pollutants for sample OW 18d. In addition, analytical results are included for extractables that were present but are not part of the priority pollutant list. Since standards for these compounds are not readily available their concentrations are calculated based on their response relative to the internal standard, dl0-phenanthrene.

Should any questions arise please do not hesitate to call.

Yours truly,


Henri Huneault
Senior Chemist

encl.

HH:kb

ZENON ID		890145	
PARAMETER		Method Blank	OW 18d
Chloromethane	1.0	<	<
Vinyl Chloride	1.0	<	<
Bromomethane	1.0	<	<
Chloroethane	1.0	<	<
Trichlorofluoromethane	1.0	<	<
1,1-Dichloroethene	1.0	<	<
Methylene chloride	1.0	5.5	4.0
trans-1,2-Dichloroethene	1.0	<	<
1,1-Dichloroethane	1.0	<	<
Chloroform	1.0	1.8	3.2
1,1,1-Trichloroethane	1.0	<	<
1,2-Dichloroethane	1.0	<	3.9
Carbon tetrachloride	1.0	<	<
Benzene	1.0	3.3	500
1,2-Dichloropropane	1.0	<	<
Trichloroethene	1.0	<	<
Bromodichloromethane	1.0	<	<
2-Chloroethylvinyl ether	1.0	<	<
cis-1,3-Dichloropropene	1.0	<	<
Toluene	1.0	1.6	9.7
trans-1,3-Dichloropropene	1.0	<	<
1,1,2-Trichloroethane	1.0	<	4.7
Dibromochloromethane	1.0	<	<
Tetrachloroethene	1.0	<	<
Chlorobenzene	1.0	<	3200
Ethylbenzene	1.0	1.6	11
m,p-Xylenes	1.0	<	11
o-Xylene	1.0	<	18
Bromoform	1.0	<	<
1,1,2,2-Tetrachloroethane	1.0	<	<
Surrogate Recovery (%)			
1,2-Dichloroethene-d4		94	103
Toluene-d8		84	87
Bromofluorobenzene		81	89

MDL -Minimum Detection Limit
 < - Less than MDL

ZENON ID

891045
1990 JAN 30 PM 1: 27

PARAMETER	MDL	Method Blank	HAMILTON OW 18d
Acenaphthene	1.0	<	<
Acenaphthylene	1.0	<	<
Anthracene	1.0	<	<
Benzo(a)anthracene	1.0	<	<
Benzo(b/k)fluoranthene	1.0	<	<
Benzo(a)pyrene	1.0	<	<
Benzo(ghi)perylene	1.0	<	<
Benzylbutylphthalate	1.0	<	<
Bis(2-chloroethoxy)methane	1.0	<	<
Bis(2-chloroethyl)ether	1.0	<	<
Bis(2-ethylhexyl)phthalate	1.0	<	<
Bis(2-chloroisopropyl)ether	1.0	<	<
4-Bromodiphenylether	1.0	<	<
2-Chloronaphthalene	1.0	<	<
4-Chlorodiphenylether	1.0	<	<
Chrysene	1.0	<	<
Dibenzo(a,h)anthracene	1.0	<	<
Di-n-butyl phthalate	1.0	<	<
1,3-Dichlorobenzene	1.0	<	<
1,2-Dichlorobenzene	1.0	<	<
1,4-Dichlorobenzene	1.0	<	<
Diethyl phthalate	1.0	<	<
Dimethyl phthalate	1.0	<	<
Di-n-octyl phthalate	1.0	<	<
2,4-Dinitrotoluene	1.0	<	<
2,6-Dinitrotoluene	1.0	<	<
Diphenylamine	1.0	<	<
Fluoranthene	1.0	<	<
Fluorene	1.0	<	<
Hexachlorobenzene	1.0	<	<
Hexachlorobutadiene	1.0	<	<
Hexachlorocyclopentadiene	1.0	<	<
Hexachloroethane	1.0	<	<
Indeno(1,2,3-cd)pyrene	1.0	<	<
Isophorone	1.0	<	<
Naphthalene	1.0	<	<
Nitrobenzene	1.0	<	6.2
N-Nitrosodi-n-propylamine	1.0	<	<
N-Nitrosodimethylamine	1.0	<	<
N-Nitrosodiphenylamine	1.0	<	<
Phenanthrene	1.0	<	<
Pyrene	1.0	<	<
1,2,4-Trichlorobenzene	1.0	<	<
4-Chloro-3-methylphenol	2.0	<	20

ZENON ID

891045

PARAMETER	MDL	Method Blank	OW 18d
2-Chlorophenol - -	2.0	<	420
2,4-Dichlorophenol	2.0	<	5.4
2-Methyl-4,6-dinitrophenol	2.0	<	<
2-Nitrophenol	2.0	<	<
4-Nitrophenol	2.0	<	<
Pentachlorophenol	2.0	<	<
Phenol	2.0	<	<
2,4,6-Trichlorophenol	2.0	<	<

% SURROGATE RECOVERY

d5-Nitrobenzene	71	92
2-Fluorobiphenyl	76	93
2,4,6-Tribromophenol	70	105
d5-Phenol	34	50
d14-p-Terphenyl	79	81

< - Not Detected at MDL

MDL - Minimum Detection Limit

Morrison & Beatty GCMS Characterization (µg/L)

Parameter	OW 18d*
Tetramethyl Urea	8.7
Isothiocyanato-Benzene	17
3-Chlorophenol	33
Benzothiazole	50
Benzothiadiazole	4.0
Methyl Benzothiazole	7.4
Chloromethyl Nitrophenol	4.9
Methylthio-Benzothiazole	12
Ethyl Benzothiazolamine	6.4
Benzothiazolone	39
Benzothiazoelethione	13
Phenoxazine	8.7
Morpholinyl Benzothiazole	5.5
Dihydromethylphenyl oxathiin carboximide	28
Hydroxyphenyl Quinazolinone	3.4

* Concentration based on d10-phenanthrene

RECEIVED MAY 18 1989

1990 JAN 30 PM 1:27

Zenon Environmental Inc.

845 Harrington Court, Burlington, Ontario L7N 3P3 Tel: (416) 639-6320 Telex: 061-8734 Fax: 639-1812
HAMILTON

File No: AN898079
Work No: A 2928
A 2943
A 2981

May 17, 1989

Ross Duncan
Morrison & Beatty
4500 Dixie Road
Unit 12 A
Mississauga, Ontario
L4W 1V7

*changed for 56
samples, received 57*

Dear Ross:

Enclosed, please find BTEX and herbicide results for samples submitted to Zenon Environmental Inc. These results include all BTEX and herbicide results from your first three submissions and additional BTEX results from the next two submission sets. The herbicides results for all remaining samples are being processed and should become available within the next few weeks. A few sites gave ppm levels of BTEX and these included OW-106d, OW-43-3 and OW37-5a. Surrogate recoveries were generally good and are summarized below:

Surrogate	Recovery	Std. Dev.
d ₄ -1,2-Dichloroethane	106	10
d ₈ -Toluene	106	11
Bromofluorobenzene	107	15

The BTEX analysis was performed using an Envirochem purge & trap analyser coupled to a Hewlett-Packard MSD. All data are corrected to the method blank.

The herbicide data showed significant levels of 2,4-D, 2-4 OP and 2,4,5-T in sample OW43-3.

After the second set of samples the surrogates were changed from deuterated PAH to phenolics, d₃-dichlorophenol and 2,4,6 tribromophenol. These compounds will extract in much the same manner as the herbicides. All samples were analysed on a Finnigan 4500 GC/MS.

MORRISON & BEATTY BTEX RESULTS (µg/L)

PARAMETER	MDL	METHOD BLANK	892619 OW-18s	892620 OW-18d	892621 OW-19s	892622 OW-19d	892623 OW-22s	892624 OW-22i	892625 OW-22d	892626 OW-106-5	892627 OW-106d
BENZENE	0.5	0.53	<	820	<	7.9	<	<	<	2.1	310
TOLUENE	0.5	<	<	<	<	15	<	<	<	<	500
ETHYL BENZENE	0.5	<	<	140	<	<	<	<	<	<	580
m,p-XYLENES	0.5	<	<	380	<	<	<	<	<	<	1300
o-XYLENE	0.5	<	<	230	<	<	<	<	<	<	630
SURROGATE RECOVERY -%											
d4-1,2-DICHLOROETHANE		92	92	105	102	103	98	99	99	101	115
d8-TOLUENE		96	97	106	102	100	90	93	93	93	114
BROMOFLUOROBENZENE		95	92	113	102	89	88	95	98	83	127

MIN. OF THE ENVIRONMENT
 ADMINISTRATIVE SECTION
 1990 JAN 30 PM 1:27
 HAMILTON

MORRISON & BEATTY BTEX RESULTS (µg/L)

		892827	892828	892829	892830	892831	892832	892833		893018	893019
PARAMETER	MDL	OW-7-3	OW-7d	OW-7-26	OW-28-5	OW-21s	OW-21d	OW-7-6	METHOD BLANK	OW-28-6	OW-5s
BENZENE	0.5	<	<	<	<	<	<	<	0.57	1.5	22
TOLUENE	0.5	<	<	2.3	2.2	<	<	<	0.65	<	6.7
ETHYL BENZENE	0.5	<	<	<	<	<	<	<	<	<	11
m,p-XYLENES	0.5	<	<	<	<	<	<	<	0.74	1.2	1.3
o-XYLENE	0.5	<	<	<	<	<	<	<	<	<	7.4
SURROGATE RECOVERY -%											
d4-1,2-DICHLOROETHANE		88	89	91	112	88	99	97	100	101	103
d8-TOLUENE		97	94	93	121	95	89	87	110	100	105
BROMOFLUOROBENZENE		95	96	96	127	102	85	73	117	100	109

MORRISON & BEATTY BTEX RESULTS (µg/L)

PARAMETER	MDL	893020	893020	893021	893022	893023	893024	893025	893025	METHOD BLANK	893109
		OW-Si	OW-Si Duplicate	OW-43-3 ¹	OW-43-5	OW-43-11	OW-6-17	OW-6-29	OW-6-29 Duplicate		OW-40-6
BENZENE	0.5	39	50	210	16	48	0.69	<	<	<	210
TOLUENE	0.5	230	330	6300	0.83	16	0.53	<	<	<	560
ETHYL BENZENE	0.5	26	19	200	<	<	<	<	<	<	66
m,p-XYLENES	0.5	8.7	18	140	<	<	<	<	<	<	320
o-XYLENE	0.5	24	14	71	<	<	<	<	<	<	120
SURROGATE RECOVERY -%											
d4-1,2-DICHLOROETHANE		101	115	122	104	101	99	101	101	99	118
d8-TOLUENE		106	113	115	104	101	97	99	102	92	116
BROMOFLUOROBENZENE		115	126	128	107	108	98	105	107	98	124

MORRISON & BEATTY BTEX RESULTS (µg/L)

PARAMETER	MDL	893110 OW-41-6	893110 OW-41-6 Duplicate	893111 OW-41-12	893112 OW-42-4	893113 OW-42-7	893114 OW-8s	893115 OW-8s	893116 OW-32-10	893117 OW-37-5a	893118 OW-38-6
BENZENE	0.5	4.3	4.3	<	850	<	6.0	0.91	0.6	92	<
TOLUENE	0.5	0.60	0.50	<	<	<	1.9	<	0.5	89	<
ETHYL BENZENE	0.5	<	<	<	<	<	3.1	<	<	1000	<
m,p-XYLENES	0.5	<	<	<	<	<	0.53	<	<	2300	<
o-XYLENE	0.5	<	<	<	<	<	0.56	<	<	1500	<
SURROGATE RECOVERY -%											
d4-1,2-DICHLOROETHANE		99	98	96	121	97	97	98	102	125	115
d8-TOLUENE		102	95	98	113	98	102	100	104	115	120
BROMOFLUOROBENZENE		117	85	108	126	108	103	105	103	139	109

MORRISON & BEATTY BTEX RESULTS (µg/L)

PARAMETER	MDL	893119 OW-40-13	METHOD BLANK	893238 OW-14s	OW-14s Duplicate	893238 OW-14i	893239 OW-32-3	893240 OW-14d	893241 OW-16s	893242 OW-16d	893243 OW-15i
BENZENE	0.5	<	0.72	<	<	<	<	<	<	<	<
TOLUENE	0.5	1.0	0.79	<	<	<	<	<	1.1	<	1.1
ETHYL BENZENE	0.5	<	<	<	<	<	<	<	<	<	<
m,p-XYLENES	0.5	<	<	<	<	<	<	<	<	<	<
o-XYLENE	0.5	<	<	<	<	<	<	<	<	<	<
SURROGATE RECOVERY -%											
d4-1,2-DICHLOROETHANE		104	111	115	113	116	119	116	118	118	118
d8-TOLUENE		95	115	123	116	127	116	121	118	122	113
BROMOFLUOROBENZENE		99	95	117	98	116	126	112	102	121	113

MORRISON & BEATTY BTEX RESULTS (µg/L)

		893245	893246	893247	893248	893249
PARAMETER	MDL	OW-15d	OW-RW7	OW-15s	OW-104s	OW-3d
BENZENE	0.5	<	<	<	<	<
TOLUENE	0.5	<	<	<	<	<
ETHYL BENZENE	0.5	<	<	<	<	140
m,p-XYLENES	0.5	<	<	<	<	31
o-XYLENE	0.5	<	<	<	<	<
SURROGATE RECOVERY -%						
d4-1,2-DICHLOROETHANE		117	124	117	118	117
d8-TOLUENE		108	116	123	114	126
BROMOFLUOROBENZENE		92	131	127	127	129

MORRISON & BEATTY HERBICIDES (µg/L)

PARAMETER	MDL	Method Blank	892619 OW 18s	892620 OW 18d	892621 OW19S	892622 OW19D	892623 OW 22S	892624 OW22I
2,4-D	0.10	<	<	0.62	<	<	<	<
2,4-DP	0.05	<	<	<	<	<	<	<
2,4,5-TP	0.10	<	<	0.89	<	<	<	<
2,4,5-T	0.10	<	<	< 0.40	<	<	<	<
2,4-DB	0.05	<	<	< 0.25	<	<	<	<
Picloram	0.05	<	<	< 0.10	<	<	<	<
Surrogate Recovery								
d10-Acenaphthene		62	75	72	76	75	69	71
d10-Anthracene		34	70	85	19	31	30	32
d12-Chrysene		63	85	77	76	75	82	69

< -Not Detected at MDL

MDL - Minimum Detection limit

MORRISON & BEATTY HERBICIDES (µg/L)

PARAMETER	MDL	892625	892626	892627
		OW22D	OW 106-5	OW 106d
2,4-D	0.10	<	<	<
2,4-DP	0.05	<	<	<
2,4,5-TP	0.10	<	< 0.35	<
2,4,5-T	0.10	<	<	<
2,4-DB	0.05	<	<	<
Picloram	0.05	<	<	<

Surrogate Recovery

d10-Acenaphthene	71	88	Interference
d10-Anthracene	47	99	85
d12-Chrysene	67	95	82

< -Not Detected at MDL

MDL - Minimum Detection limit

MORRISON & BEATTY HERBICIDES (µg/L)

PARAMETER	MDL	Method Blank	892827 OW 7-3	892828 OW 7d	892829 OW 7-26	892830 OW 28-5	892831 OW 21s	892832 OW 21d	892833 OW 7-6
2,4-D	0.10	<	<	<	<	Trace	<	<	<
2,4-DP	0.05	<	<	0.47	<	0.54	<	<	<
2,4,5-TP	0.10	<	<	<	<	<	<	<	2.4
2,4,5-T	0.10	<	<	<	<	<	<	<	Trace
2,4-DB	0.05	<	<	<	<	<	<	<	<
Picloram	0.05	<	<	<	<	Trace	<	<	<
Surrogate Recovery									
d10-Acenaphthene		64	117	101	77	71	74	46	64
d10-Anthracene		11	88	60	61	41	89	40	51
d12-Chrysene		82	114	93	87	76	82	53	79

< -Not Detected at MDL

MDL - Minimum Detection limit

MORRISON & BEATTY HERBICIDES (µg/L)

PARAMETER	MDL	Method Blank	893018 OW 28-6	893019 OW-5s	893020 OW 5i	893021 OW 43-3	893022 OW 43-5	893023 OW 43-11
2,4-D	0.10	<	<	<	< 0.50	22	<	<
2,4-DP	0.05	<	<	< 0.18	0.89	7.9	17	6.5
2,4,5-TP	0.10	<	<	<	<	2.9	1.8	0.74
2,4,5-T	0.10	<	<	<	<	21	<	<
2,4-DB	0.05	<	<	<	<	<	<	<
Picloram	0.05	<	<	<	<	<	<	< 0.09
Surrogate Recovery-%								
d3-Dichlorophenol		66	65	102	117	Interference	Interference	53
2,4,6-Tribromophenol		83	108	122	109	111	108	111

< -Not Detected at MDL

MDL - Minimum Detection limit

MORRISON & BEATTY HERBICIDES (µg/L)

PARAMETER		893024	893025
	MDL	OW 16-7	OW 6-29
2,4-D	0.10	<	<
2,4-DP	0.05	<	<
2,4,5-TP	0.10	<	<
2,4,5-T	0.10	<	<
2,4-DB	0.05	<	<
Picloram	0.05	<	<
Surrogate Recovery-%			
d3-Dichlorophenol		22	48
2,4,6-Tribromophenol		6	51

< -Not Detected at MDL

MDL - Minimum Detection limit



MORRISON & BEATTY

May 17, 1989

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Surrogate recoveries are summarized below:

Surrogate	Recovery	Std. Dev.
d10 Acenaphthene	75	16
d10 Anthracene	54	27
d12 Chrysene	80	13
d3 Dichlorophenol	68	32
2,4,6 Tribromophenol	90	38

Should any questions arise please do not hesitate to call.

Yours truly,

Henri Huneault
Project Manager

Encl.

HH:sk



morrison beatty

Consulting Engineers and Hydrogeologists

FAX TRANSMITTAL

TRANSMISSION TO: BOB HILLIER, MOE WEST CENTRAL

FAX NUMBER: 1-521-7181

ATTENTION:

PROJECT: UNIROYAL

OUR FILE NO: 225-894

FROM: R. DUNCAN

DATE: FEB 5/90 TIME: 12³⁰ P PREPARED BY: RB

NUMBER OF PAGES INCLUDING COVER: 16

ORIGINAL TO FOLLOW: NO YES VIA: IN ANNUAL MONITORING REPORT

COMMENTS:

EPA 624/625 RESULTS, VARIOUS WELLS

<u>WELL NO.</u>	<u>LISTED ON LAB SHEET AS:</u>	<u>SAMPLED ON:</u>
56-16	75s	Nov 9/89
56-25	75i	"
56-33	75d	"
57-4335	76i	"
22d		
104d		
106d		
MoE 1B & 1C		

} Nov 14/89

4500 Dixie Rd., Unit 12A, Mississauga, Ont. L4W 1V7 Tel: (416) 624-9308 Fax: (416) 624-2334
Dartmouth, Nova Scotia (902) 468-3844 Sydney, Nova Scotia (902) 564-4041

MORRISON & BEATTY - EPA 624 PRIORITY POLLUTANTS (µg/L)

			011869	011870	011871	011872	012125
PARAMETER	MDL	Method Blank	<i>56-16</i> OW-75s	<i>56-25</i> OW-75i	<i>56-33</i> OW-75d	<i>57-93</i> OW-76i	OW-22d
Chloromethane	2.3	<	<	<	<	<	<
Vinyl Chloride	2.9	<	<	<	<	<	<
Bromomethane	2.4	<	<	<	<	<	<
Chloroethane	2.3	<	<	<	<	<	<
Trichlorofluoromethane	0.3	<	<	<	<	<	<
1,1-Dichloroethene	0.4	<	<	<	<	2.7	<
Methylene chloride	0.3	7.3	<	<	<	<	<
trans-1,2-Dichloroethene	1.1	<	<	1.9	<	1.3	<
1,1-Dichloroethane	0.5	<	<	8.9	<	12	<
Chloroform	0.4	<	<	<	<	3.1	<
1,1,1-Trichloroethane	0.6	<	<	<	<	6.4	<
1,2-Dichloroethane	0.4	<	<	<	<	<	<
Carbon tetrachloride	0.3	<	<	<	<	<	<
Benzene	0.2	1.2	<	14	<	110	<
1,2-Dichloropropane	0.5	<	<	<	<	<	<
Trichloroethene	0.3	<	<	<	<	0.93	<
Bromodichloromethane	0.4	<	<	<	<	<	<
2-Chloroethylvinyl ether	2.7	<	<	<	<	<	<
cis-1,3-Dichloropropene	0.7	<	<	<	<	<	<
Toluene	0.3	2.9	<	<	<	16	<
trans-1,3-Dichloropropene	1.1	<	<	<	<	<	<
1,1,2-Trichloroethane	0.3	<	<	<	<	<	<
Dibromochloromethane	0.4	<	<	<	<	<	<
Tetrachloroethene	0.2	0.5	<	<	<	1.3	<
Chlorobenzene	0.6	<	<	170	<	1200	<
Ethylbenzene	0.3	<	<	2.2	<	3.1	<
Bromoform	2.4	<	<	<	<	<	<
1,1,2,2-Tetrachloroethane	0.3	<	<	<	<	<	<
Surrogate Recovery (%)							
1,2-Dichloroethane-d4		93	91	92	96	90	99
Toluene-d8		101	102	96	98	85	101
Bromofluorobenzene		99	111	105	105	91	108
Dilution factor			1	1	1	1	1

MDL -Minimum Detection Limit

< - Less than MDL

Results are blank corrected

ZENON ENVIRONMENTAL INC.

MORRISON & BEATTY - EPA 624 PRIORITY POLLUTANTS (µg/L)

		12126	12127	12128	12129	012130
PARAMETER	MDL	OW-104d	OW-18d	OW-106d	MOE1B	MOE1C
Chloromethane	2.3	<	<	<	<	<
Vinyl Chloride	2.9	<	<	<	<	<
Bromomethane	2.4	<	<	<	<	<
Chloroethane	2.3	<	<	<	<	<
Trichlorofluoromethane	0.3	<	<	<	<	<
1,1-Dichloroethene	0.4	<	<	<	<	<
Methylene chloride	0.3	<	<	<	<	5.2
trans-1,2-Dichloroethene	1.1	<	<	<	<	5.1
1,1-Dichloroethane	0.5	62	<	<	<	<
Chloroform	0.4	<	<	<	<	0.47
1,1,1-Trichloroethane	0.6	1000	<	<	<	<
1,2-Dichloroethane	0.4	<	<	<	<	<
Carbon tetrachloride	0.3	<	<	<	<	<
Benzene	0.2	34	<	<	<	42
1,2-Dichloropropane	0.5	<	<	<	<	<
Trichloroethene	0.3	54	<	<	<	<
Bromodichloromethane	0.4	<	<	<	<	<
2-Chloroethylvinyl ether	2.7	<	<	<	<	<
cis-1,3-Dichloropropene	0.7	<	<	<	<	<
Toluene	0.3	<	<	<	<	4.5
trans-1,3-Dichloropropene	1.1	<	<	<	<	<
1,1,2-Trichloroethane	0.3	<	<	<	<	1.4
Dibromochloromethane	0.4	<	<	<	<	<
Tetrachloroethene	0.2	<	<	<	<	<
Chlorobenzene	0.6	740	46000	9200	160	27
Ethylbenzene	0.3	<	<	<	<	<
Bromoform	2.4	<	<	<	<	<
1,1,2,2-Tetrachloroethane	0.3	<	<	<	<	<

Surrogate Recovery (%)

1,2-Dichloroethane-d4	102	105	113	108	99
Toluene-d8	34	38	37	37	100
Bromofluorobenzene	120	112	99	99	107
Dilution factor	20	800	400	40	1

MDL - Minimum Detection Limit

< - Less than MDL

Results are blank corrected

ZENON ENVIRONMENTAL INC.

ZENON ENVIRONMENTAL INC.

< - Less than MDL
MDL - Minimum Detection Limit

Surrogate Recoveries - %

31	68	76	84	77	27	58	63	66	23	72	77	22	41	65	80	86
Phenol	1.1	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2-chlorophenol	1.8	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dichlorophenol	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
1,4-dichlorobenzene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
1,2-dichlorobenzene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2-chlorophenyl ether	2.7	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2-chlorophenol	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dichlorophenol	1.7	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dichlorophenyl methyl ether	1.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dichlorophenol	1.2	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
1,2,4-trichlorobenzene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Naphthalene	0.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Hexachlorobenzene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Heptachlorobenzene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Heptachlorocyclopentadiene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4,6-trichlorophenol	1.2	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2-chloronaphthalene	0.9	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
1-chloronaphthalene	0.4	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
1-chloronaphthalene	0.4	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
1-chloronaphthalene	1.1	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,5-dinitrophenol	0.6	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dinitrophenol	0.7	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dinitrophenol	4.8	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
2,4-dinitrophenol	0.5	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
4-nitrophenol	1.4	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Fluorene	0.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
4-chlorophenylphenyl ether	0.9	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Dibenzophthalene	1.1	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
4,5-Dinitro-2-methylphenol	1.5	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
n-nitrophenylphenyl ether	1.9	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
4-bromophenylphenyl ether	0.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Hexachlorobenzene	2.0	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Perachlorophenol	1.1	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Phenanthrene	0.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
A nitracene	0.2	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
D-n-butyl phthalate	1.1	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Fluoranthene	0.2	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Pyrene	0.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Phenyl butyl phthalate	0.6	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Benzo(a)anthracene	0.2	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Chrysene	0.3	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Blue(2-ethylhexyl)phthalate	3.5	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Di-n-octylphthalate	1.1	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Benzo(b)fluoranthene	0.4	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Benzo(a)pyrene	0.5	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Indeno(1,2,3-c-d)pyrene	0.6	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Dibenz(a,h)anthracene	0.4	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
Benzo(g,h,i)perylene	0.4	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<

PARAMETER MDL

Blank Method

011869 56-16 79-8
011870 56-25 79-1
011871 56-33 79-D
011872 57-33 76-1
012135 OW22D

MORRISON & BEATTY - 625 ANALYSIS (µg/L)

		012126	012127	012128	012129	012130
		OW104D	OW16D	OW104D	MOE-1B	MOE-1C
PARAMETER	MDL					
Phenol	1.1	<	<	<	<	<
Bis(2-chloroethyl)ether	1.8	<	<	<	<	<
2-Chlorophenol	2.7	<	1400	230	<	<
1,3-Dichlorobenzene	2.0	<	<	<	<	<
1,4-Dichlorobenzene	2.0	<	<	<	<	<
1,2-Dichlorobenzene	2.0	<	<	<	<	<
Bis(2-chloroisopropyl)ether	1.5	<	<	<	<	<
Hexachloroethane	2.0	<	<	<	<	<
n-nitrosodi-n-propylamine	2.1	<	<	<	<	<
Nitrobenzene	2.0	<	<	<	610	<
Isophorone	4.0	<	<	<	<	<
2-Nitrophenol	1.4	<	<	<	<	<
2,4-dimethylphenol	1.7	<	<	<	<	<
Bis(2-chloroethyl)methane	1.3	<	<	<	<	<
2,4-dichlorophenol	1.2	<	930	400	<	<
1,2,4-Trichlorobenzene	2.0	<	<	<	<	<
Naphthalene	0.3	<	<	20	<	<
Hexachlorobutadiene	2.0	<	<	<	<	<
4-chloro-3-methylphenol	1.4	<	<	<	<	<
Hexachlorocyclopentadiene	2.0	<	<	<	<	<
2,4,6-trichlorophenol	1.2	<	2.8	<	<	<
2-Chloronaphthalene	0.9	<	<	<	<	<
Acenaphthylene	0.4	<	<	<	<	<
Dimethylphthalate	1.1	<	<	<	<	<
2,6-dinitrotoluene	0.6	<	<	<	<	<
Acenaphthene	0.7	<	<	<	<	<
2,4-dinitrophenol	4.8	<	<	<	<	<
2,4-dinitrotoluene	0.5	<	<	<	<	<
4-Nitrophenol	1.4	<	<	<	<	<
Fluorene	0.3	<	<	<	<	<
4-chlorophenyl phenylether	0.9	<	<	<	<	<
Diethylphthalate	1.1	<	<	<	<	<
4,6-Dinitro-2-methylphenol	1.5	<	<	<	<	<
n-nitrosodiphenylamine	1.9	5.5	56	230	<	<
4-bromophenyl phenyl ether	0.3	<	<	<	<	<
Hexachlorobenzene	2.0	<	<	<	<	<
Pentachlorophenol	1.1	<	5.0	2.5	<	<
Phenanthrene	0.3	<	<	<	<	<
Anthracene	0.2	<	<	<	<	<
Di-n-butyl phthalate	1.1	<	<	<	<	<
Fluoranthene	0.2	<	<	<	<	<
Pyrene	0.3	<	<	<	<	<
Benzyl butyl phthalate	0.6	<	<	<	<	<
Benzo(a)anthracene	0.2	<	<	<	<	<
chrysene	0.3	<	<	<	<	<
Bis(2-ethylhexyl)phthalate	1.4	<	<	<	<	<
Di-n-octylphthalate	1.1	<	<	<	<	<
Benzo(b,k)fluoranthene	0.4	<	<	<	<	<
Benzo(a)pyrene	0.3	<	<	<	<	<
Indeno(1,2,3-c,d)pyrene	0.6	<	<	<	<	<
Di benzo(a,h)anthracene	0.4	<	<	<	<	<
Benzo(g,h,i)perylene	0.4	<	<	<	<	<
Surrogate Recoveries-%						
d5-Phenol		27	54	26	32	35
d5-Nitrobenzene		49	42	58	89	58
2-Fluorobiphenyl		75	53	65	60	63
2,4,6-Tribromophenol		85	97	117	80	88
d14-p-Terphenyl		78	61	77	69	74

MDL - Minimum Detection Limit
< - Less than MDL

ZENON ENVIRONMENTAL INC.

MORRISON BEATTY (µg/L)

PARAMETER	IDL	Method Blank	011869	011870	011871	011872	012125	012126
			<i>56-10</i> 75-S	<i>56-25</i> 75-I	<i>56-33</i> 75-D	<i>57-23</i> 76-I	OW22D	OW104D
N-Nitrosodimethylamine	2.0	<	<	18	<	<	<	<
IDL - Instrument Detection Limit								
< - Less than IDL								

MORRISON BEATTY (µg/L)

PARAMETER	IDL	012127	012128	012129	012130
		OW18D	OW106D	MOE-IB	MOE-1C
N-Nitrosodimethylamine	2.0	<	<	50	170
IDL - Instrument Detection Limit					
< - Less than IDL					

APPENDIX "J"

Background information regarding NDMA and health criteria including:

- Ontario Gazette excerpt,
Table (Part 10) for Regulation 654/86 passed under
the Occupational Health and Safety Act R.S.O.
1980.
- Letters dated November 19, 1989, and January 10 and 23,
1990
from R. S. Tobin, Acting Chief, Monitoring and
Criteria Division of Health and Welfare Canada to
Ms A. Vajdic, Ontario Ministry of the Environment,
Drinking Water Section.
- Letter dated February 13, 1990
from A. Vajdic, Ontario Ministry of the
Environment, Drinking Water Section to Mr. T. C.
Flannery.

**PART 10 Known Toxic Agents for Which Exposure Values Have
Not Been Established, and to Which Any Exposure
Should be Avoided**

<u>Agent</u>	<u>(CAS Reg. No.)</u>
Benzidine — Skin	(92-87-5)
Benzo(a)pyrene	(50-32-8)
(1,1'-Biphenyl)-4-amine — Skin	(92-67-1)
Chloromethyl methyl ether	(107-30-2)
Chrysene	(218-01-9)
1,2-Dibromoethane — Skin	(106-93-4)
3,3'-Dichlorobenzidine — Skin	(91-94-1)
3,3'-Dimethyl-(1,1'-biphenyl)-4,4'-diamine — Skin	(119-93-7)
Dimethylcarbamoyl chloride	(79-44-7)
Hexamethylphosphoric triamide — Skin	(680-31-9)
beta-Naphthylamine	(91-59-8)
4-Nitrobiphenyl	(92-93-3)
N-Nitrosamines — Skin (e.g. N-Nitrosodimethylamine)	(a)
1,2-Oxathiolane 2,2-dioxide	(1120-71-4)
N-Phenyl-beta-naphthylamine	(135-88-6)

son 675 of Revised Regulations
to, 1970, amended by adding
the following sections:

248.—(1) Notwithstanding any other provision of this Order, a single-family dwelling and buildings and structures accessory thereto may be erected and used on the land described in subsection (2) if the following requirements are met:

Minimum front yard	7.6 metres
Minimum side yards	3 metres on one side and 1.2 metres on the other side
Maximum height of single-family dwelling	9.1 metres
Minimum ground floor area of single-family dwelling	one storey—93 square metres one and one-half storeys or more—69.8 square metres

(2) Subsection (1) applies to that parcel of land in the Township of Nottawasaga in the County of Simcoe, being that part of Lot 39 in Concession X described as follows:

Premising that bearings herein are astronomic and are derived from Department of Highway's Plan P-2574-4 registered in the Land Registry Office for the Registry Division of the County of Simcoe (No. 51) as Instrument Number 21407;

Commencing at an iron survey bar set in the northerly limit of the said Lot 39 and distant 2,242.02 feet measured easterly therealong from the northwest angle thereof;

Thence south $16^{\circ} 25' 30''$ east, and being along the easterly limit of the lands owned by the Baptist Cemetery Trust, a distance of 660 feet to an iron survey bar;

Thence south $73^{\circ} 34' 30''$ west, and being along the southerly limit of the said Cemetery lands, a distance of 231 feet to an iron survey bar;

Thence south $16^{\circ} 25' 30''$ east a distance of 340.75 feet to an iron survey bar set in the existing line between the north and south halves of the said Lot 39;

Thence north $73^{\circ} 41' 30''$ east, along the said existing half lot line, a distance of 462 feet to an iron survey bar;

Thence north $16^{\circ} 25' 30''$ west, a distance of 1,001.36 feet to an iron survey bar set in the northerly limit of the said Lot 39.

Thence south $73^{\circ} 34' 30''$ west, along the southerly limit, a distance of 231 feet to the point of commencement. O. Reg. 653/86, s. 1.

L. J. FINCH

Director

Plans Administration Branch
Central and Southern
Ministry of Municipal Affairs

Dated at Toronto, this 29th day of October, 1986

(9667) **APPENDIX J**

OCCUPATIONAL HEALTH AND SAFETY ACT

O. Reg. 654/86.

Control of exposure to Biological or Chemical Agents.

Made—November 6th, 1986.

Filed—November 6th, 1986.

REGULATION MADE UNDER THE OCCUPATIONAL HEALTH AND SAFETY ACT

CONTROL OF EXPOSURE TO BIOLOGICAL OR CHEMICAL AGENTS

1. In this Regulation, "exposure" means exposure by inhalation, ingestion or skin contact. O. Reg. 654/86, s. 1.

2. This Regulation does not apply to a project of an employer who primarily carries on the business of construction or to the workers of such an employer. O. Reg. 654/86, s. 2.

3.—(1) Every employer shall take all measures reasonably necessary in the circumstances to protect workers from exposure to a hazardous biological or chemical agent because of the storage, handling, processing or use of such agent in the work place.

(2) The measures referred to in subsection (1) shall include the provision and use of engineering controls, work practices, hygiene facilities and practices and, subject to section 6, personal protective equipment. O. Reg. 654/86, s. 3.

4. Without limiting the generality of section 3, but subject to section 9, every employer shall take the measures prescribed in that section to limit the daily and weekly exposure of workers to a biological or chemical agent listed in the Schedule to the concentration limit expressed as a time-weighted average exposure value, a short-term exposure value or a ceiling exposure value set out for the agent in the Schedule determined in accordance with the methods set out in the Schedule. O. Reg. 654/86, s. 4.

2330

ical Names, Notations

logical and chemical agents
Abstracts Service Registry

onform with nomenclature
Applied Chemistry or with
d under one name and its
, and trade) will be cross-

in. O-, N-, sec-, tert-) are
phabetical order, but are
names are identical. For
, and "sec-butyl acetate"

er (CAS Reg. No.) is a
al substance in the CAS
ervice (P.O. Box 3012,
elf has no chemical or
ter-verifiable number
is entered in the CAS
ted in this guide were
States Environmental
s. have been used as
d computer literature-

The CAS Reg. No. has the format (xxxxxx-xx-x) and consists of up to 9 digits, separated by hyphens into 3 groups: (1) the first group has up to 6 digits; (b) the second always contains 2 digits; and (c) the third contains 1 digit.

Under the CAS Reg. No. heading some entries other than the CAS Reg. No. have been inserted; e.g., (a), (b), (c), as shown below:

Example: Agent

Symbol Comment CAS Reg. No.

(a) A CAS Reg. No. has not been assigned.

Cotton dust, raw
(a)

(b) The CAS Reg. No. is for the parent substance only. In the example given, cobalt is a parent compound. CAS Reg. Nos. have been assigned to individual compounds; e.g.: cobalt chloride.

Cobalt and its compounds
(as cobalt)
(7440-48-4), (b)

(c) A CAS Reg. No. exists but has not been included here because reference to the CAS Reg. No. data base could be misleading.

Glass, fibrous or dust
(c)

Notations

The notation "skin" following the name of an agent in this Schedule indicates that direct or airborne contact with the agents may result in significant absorption of the agent through the skin, mucous membranes or eyes. Vehicles, such as certain solvents, may enhance the rate of skin absorption. Inclusion of this notation is intended to suggest that

preventative action should be taken against absorption of the agent through the skin, mucous membranes or eyes.

(As...) - In the lists of biological and chemical agents, the notation "(as...)", e.g.: "nickel carbonyl (as nickel)", is used to indicate that the agent is to be analyzed for the substance indicated in parentheses, nickel in this example, rather than nickel carbonyl.

2360



Health and Welfare
Canada

Santé et Bien-être social
Canada

Health Protection
Branch

Direction générale de la
protection de la santé

Environmental Health Centre
Tunney's Pasture
Ottawa, Ontario
K1A 0L2

November 19, 1989

Ms. Ann Vajdic
Drinking Water Section
Ontario Ministry of the Environment
135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

Dear Ms. Vajdic:

Thank you for your letter of November 14, 1989, in which you requested an assessment of the health effects of exposure to N-nitrosodimethylamine.

N-nitrosodimethylamine (NDMA) may be present in drinking water predominantly as a result of the nitrosation of nitrate, nitrite, amine or amide precursors. It is used in the plastics and rubber industries and is present in some cutting oils. It may also be introduced into water as a contaminant or nitrosation product of some pesticides since NDMA is readily leached through the soil to ground water. N-nitrosodimethylamine is also present in many foodstuffs and in cigarette smoke.

NDMA has been carcinogenic by various routes of administration in both long and short term bioassays in all species of experimental animals tested, including several strains of mice, rats and hamsters, as well as guinea pigs, mastomys, rabbits, monkeys, foxes, ducks, various fish, newts and frogs. The primary sites of tumour formation are the liver, kidney and lung. Daily doses of NDMA in drinking water as low as 0.4 and 0.05 mg/kg-bw have induced increases in the incidence of tumours in mice and rats, respectively. Based on the weight of evidence of carcinogenicity in animals, the International Agency for Research on Cancer has classified NDMA as being "probably carcinogenic in humans".

Other adverse effects observed in animals administered NDMA have included haemorrhaging, necrosis and cirrhosis of the liver, spongiosis, hepatitis, and the inhibition of protein and amino acid synthesis in the liver. Hepatic damage has been reported in mink consuming doses as low as 0.1 mg/kg-bw/day. N-nitrosodimethylamine has been mutagenic in several in vivo and in vitro assays and teratogenic when administered late in pregnancy to mice, rats and hamsters. It is foetotoxic in mice at doses as low as 0.02 mg/kg-bw/day.

.../2

Canada

Little information on the health effects of NDMA in humans is available; however, the metabolic pathway in man appears to be similar to that in animals. Exposure of four men to NDMA in the laboratory is believed to have resulted in liver necrosis which developed into cirrhosis.

A quantitative assessment of the lifetime cancer risk associated with the ingestion of NDMA in drinking water based on the extensive toxicological data reported in the literature has not been conducted, due to the lack of resources available to commit to such a large task for a chemical not identified as a priority in revision of the "Guidelines for Canadian Drinking Water Quality". However, based on the potent carcinogenicity of NDMA in experimental animals, and its probable carcinogenicity in humans, it is recommended that exposure to this compound be minimized. Therefore, it is desirable that concentrations of NDMA in drinking water be below the level of detection of the most reliable analytical method available. It is recommended that the source of the NDMA contamination in Elmira be identified and eliminated to the extent possible.

We have not been able to obtain the original study upon which the U.S. Environmental Protection Agency estimates of increased cancer risk (10^{-3} , 10^{-6} and 10^{-7} associated with exposure to NDMA concentrations in ambient water and resulting additional intake in fish and shellfish of 14, 1.4 and 0.14 ng/L, respectively,) were based. We are unable to comment, therefore, on the validity of this assessment or the resulting estimates of risk. The states of Kansas and Minnesota have apparently used these figures to establish acceptable concentrations of NDMA in drinking water of 0.0014 and 0.014 $\mu\text{g/L}$, respectively.

We have extremely limited resources for the ad hoc development of guidance values and provision of assessments on chemicals which have not been identified as priorities for consideration in the revision of the "Guidelines for Canadian Drinking Water Quality". In the past year, we have dedicated considerable time to the examination of data on at least 10 compounds at the request of the Water Resources Branch of the Ministry of the Environment. In view of our other priorities, limited resources for this task and your needs in this area, I suggest that you investigate alternative possibilities for acquiring such assessments.

I hope that this information is useful to you.

Sincerely,

R. S. Tobin

R.S. Tobin, Ph.D.
Acting Chief,
Monitoring and Criteria Division

Health Protection
Branch

Direction générale de la
protection de la santé

Environmental Health
Centre
Tunney's Pasture
Ottawa, Ontario
K1A 0L2

January 10, 1990

HUU These
2 letters
Dated
Jan. 10 +
25th
from R.S.
Tobin
To Anne

Ms. A. Vajdic, Supervisor
Program Development Unit
Ontario Ministry of the Environment
135 St. Clair Avenue West, Suite 100
Toronto, Ontario
M4V 1P5

Dear Ms. Vajdic:

In response to your request and that from the Medical Services Branch of this Department for an assessment of the potential health implications of exposure to N-nitrosodimethylamine (NDMA) in drinking water, staff of this Division have reviewed relevant literature available to them over the past few days. An evaluation of this information is attached.

An interim guidance value of 12 ng/L is recommended for NDMA in drinking water at this time. This value is based on a limited carcinogenicity bioassay in rats and is associated with a lifetime cancer risk of 10^{-5} .

We are attempting currently to obtain data from a more extensive bioassay conducted recently in the United Kingdom, which may be available to us in the next week. The recommended interim guidance value of 12 ng/L may be revised, upon receipt and assessment of these data.

I hope that this information is useful to you.

Sincerely,

R.S. Tobin

R.S. Tobin, Ph.D.
Chief, Monitoring &
Criteria Division

Canada

EVALUATION OF HEALTH RISKS OF NDMA

January 10, 1989

Humans are exposed to N-nitrosodimethylamine (NDMA) in various media. It is present in foods, air, water, tobacco smoke and cosmetics; NDMA is also formed in the human gastrointestinal tract. In most cases, food is believed to be the primary source of NDMA.

N-nitrosodimethylamine is readily absorbed from the gastrointestinal tract and is rapidly metabolised. It also appears to be absorbed from the lungs during inhalation, although the degree of absorption is not well known. Based on review of the limited information available concerning dermal absorption, very little of the NDMA present at the low levels found in water is expected to be absorbed through the skin.

N-nitrosodimethylamine has been carcinogenic in all species of laboratory animals examined in both long and short term bioassays conducted to date, with the liver being the primary site of tumour formation and other toxic effects. The carcinogenicity is believed to be due to a metabolite, rather than the parent compound. Although information on the carcinogenicity of this compound in humans has not been identified, it is likely that the metabolism of NDMA in animals and humans is similar and on this basis, it has been classified by the International Agency for Research on Cancer as "probably carcinogenic to humans."

The dose-response relationship for the carcinogenicity of this compound has been examined in very few studies. Based on extrapolation of the data obtained in an older, limited study in rats, the concentrations of NDMA in drinking water associated with a range of lifetime cancer risks which are considered to be "essentially negligible" are as follows: (This study was considered to be more appropriate than that upon which the EPA Ambient Water Quality Guideline appears to be based).

<u>Risk</u>	<u>Concentration</u>
10^{-6}	120 ng/L
10^{-4}	12 ng/L

Although a more extensive carcinogenicity bioassay in rats has been recently conducted in the United Kingdom, original data from this study are not currently available for assessment; we are attempting to obtain these data from the authors.

Pending receipt and assessment of the relevant data from the more recent and extensive study, an interim guidance value of 12 ng/L has been derived for NDMA. This is the concentration associated with an estimated lifetime cancer risk of 10^{-4} , the value considered to be appropriate in this case, since drinking water is often not the principal source of exposure to NDMA.

Guidance values do not receive the same level of review as maximum acceptable concentrations approved by the Federal-Provincial Subcommittee on Drinking Water, and should not be cited nor circulated widely. Moreover, it should be noted that the recommended interim value of 12 ng/L may be revised shortly upon receipt of more complete toxicological data.



Health and Welfare
Canada

Santé et bien-être social
Canada

Health Protection
Branch

Direction générale de la
protection de la santé

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5.

Environmental Health
Centre
Tunney's Pasture
Ottawa, Ontario
K1A 0L2

January 25, 1990

Ms. A. Vajdic
Drinking Water Section
Ontario Ministry of the Environment
135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

Dear Ms. Vajdic:

I would like to bring to your attention a typographical error in my letter to you of November 19, 1989, concerning health effects of N-nitrosodimethylamine (NDMA).

The last sentence in the third paragraph on the second page should read: "The states of Kansas and Minnesota have apparently used these figures to establish acceptable concentrations of NDMA in drinking water of 0.0014 and 0.014 µg/L, respectively".

I apologize for any inconvenience this may have caused.

Sincerely,

R.S. Tobin, Ph.D.
Chief,
Monitoring and Criteria
Division



135 St. Clair Avenue East
Suite 100
Toronto, Ontario
M4V 1P5

135 Avenue St.
Bureau 100
Toronto (Ontario)
M4V 1P5

Phipps and Flannery
Barristers and Solicitors
Attn. Timothy C. Flannery
314, Frederick Street
Kitchener.
Ontario.
N2H 2N7.

February 13 1990

Dear Mr. Flannery:

Thank you for your letter in which you inquire about the interim guideline level being used by the Ministry of the Environment for N-nitrosodimethylamine (NDMA) in the Elms situation.

When a contaminant is detected in drinking water, an assessment is required immediately of the risk to human health, to enable decisions to be made regarding the action to be taken. A review of available guidelines applicable to drinking water is carried out, as well as the collection of information on the toxicity, persistence, methods of treatment etc.

In the case of NDMA, a review of the information in the literature revealed the substance to be a potent, probable human carcinogen. There was no Canadian or Ontario drinking water guideline level for NDMA. The only guideline applicable to drinking water which could be located was the published

necessity for remedial action. The interim guideline level of 14 ng/L was recommended, based on the following considerations;

- a risk level of between 1/100,000 and 1/1000,000 is generally considered acceptable in the setting of drinking water guidelines;

- exposure was not expected to be lifetime, which provides some margin of safety;

- drinking water consumption in Canada is assumed to be 1.5 litres per day, which provides an additional margin of safety

The recommended interim guideline therefore, would be associated with a risk of between 1/100,000 and 1/1000,000. Further, discussions with Ministry of the Environment Laboratory Services Branch staff revealed that the probable limit of detection for NDMA was about 10 ng/L.

This interim guideline level, as well as the background information on the contaminant, was supplied to the Medical Officer of Health and used as the basis for action. It should be noted that the final decision regarding the safety of a water supply for consumption lies with the Medical Officer of Health.

In developing interim guidelines, it is not possible to carry out a full and detailed health assessment (including a critical review of the data used by the US EPA in deriving their published criteria value) because of the urgency of response required in an emergency situation. Further, the Ministry of the Environment does not have the staff with Medical/Toxicological expertise, able to carry out these critical assessments. However, an immediate request was made to Health and Welfare Canada for such an assessment, leading to the recommendation of a guidance value to be used for NDMA in drinking water. This request resulted in the response which you attached to your letter (letter from Dr. R. Tobin, dated November 19 1989).

Following receipt of Health and Welfare Canada's response, a request for a detailed health assessment was made of the Health Studies Service of the Policy and Regulations Branch of the Ontario Ministry of Labour (HSS). HSS did not indicate, during the course of their assessment, any disagreement with the use of the recommended interim guideline level.

I trust that this information is sufficient for your purposes.

Yours faithfully,


Ann H. Vajdic

APPENDIX "K"

NDMA sampling and analysis protocols

- Instrumental analysis of N-Nitrosodimethylamine (NDMA)
- N-Nitrosodimethylamine Field Sampling Protocol

January 22, 1990

Instrumental analysis of N-nitrosodimethylamine (NDMA):

The sample extracts are analyzed by gas chromatography/high resolution mass spectrometry (GC/HRMS). HRMS is an accepted technique for differentiating between the analyte of interest and chemical interferences. The United States Environmental Protection Agency (US-EPA) has issued Method 1613 which is a GC/HRMS method for analyzing chlorinated dibenzo-p-dioxins and dibenzofurans. By performing single ion monitoring at a mass resolution of 10,000, the dioxins can be differentiated from chemical interferences such as polychlorinated biphenyls (PCB). In the same way, NDMA can be analyzed and differentiated from chemical interferences by HRMS. The exact masses for NDMA and a common ester fragment are m/z 74.0480 for $C_2H_6N_2O$ and m/z 74.0368 for $C_3H_6O_2$ respectively. On a single quadrupole mass spectrometer which is restricted to low resolution mass spectrometry (LRMS), these masses are indistinguishable from each other. The necessary mass resolution required to differentiate these masses is 6,607 (74/74.0480-74.0368). By operating the high resolution mass spectrometer at a mass resolution of 7,000, the NDMA can be differentiated from chemical interferences. The HRMS technique results in values that are more accurate than those obtainable by LRMS.

The isotope dilution method of analysis requires that a known amount of an isotopically-labelled analogue (d_6 -NDMA) of the analyte (NDMA) be added to the matrix prior to sample extraction, cleanup and instrumental analysis. The d_6 -NDMA has identical physical and chemical properties as NDMA in the analysis. The results obtained by measuring the ratio of NDMA to d_6 -NDMA are automatically corrected for response factor (signal strength) and recovery (extraction efficiency). Therefore, the results obtained by the isotope dilution technique are more accurate than any other internal or external standard method.

V.Y. Taguchi

V.Y. Taguchi, Ph.D.
Supervisor
Mass Spectrometry Laboratory

/NDMA2

N-Nitrosodimethylamine Field Sampling Protocol

1.0 Background

Some results of N-Nitrosodimethylamine (NDMA) sampling to date have been difficult to interpret. It is therefore crucial that all sources of error that may arise in both the field and laboratory are minimized. In order to minimize all sampling error sources, a consistent and technically valid approach is required to obtain a representative sample of the water in question. In addition, owing to the extremely low detection limit for NDMA, it is very important that all samplers follow the following protocol exactly at all times.

2.0 Sampling Protocol

2.1 Bottles

All samples shall be collected in the standard MOE 3P 1 L. amber glass bottles with teflon lined caps. The bottles should be completely filled so that no head space exists. Caps should be tightened sufficiently to prevent leakage and possible contamination by the surrounding air.

2.2 Taking the Sample

Wherever possible the sample bottle should be filled directly in the section of the stream with the majority of flow. The bottle must be immersed below the water surface facing upstream and allowed to fill completely. Do not pre-rinse the sample bottle.

If the station location requires the use of a container to collect the sample, it must be constructed of either glass or stainless steel. The container should be pre-rinsed three times with the water representative of the station to be sampled prior to filling the sample bottle. Prior to the sampling survey, the sample bucket should be washed in hot, soapy water followed a tap and distilled water rinse. Solvent rinsing of the bucket is not necessary.

If using a sample bucket, the order of sampling should be such that "cleaner" stations are sampled before those in which NDMA contamination may be suspected. For example, upstream control stations must be sampled before downstream waters and sewage treatment plant effluents. Sewage treatment plant effluents are sampled before influents. If possible, dedicate specific sampling buckets for "clean" (stream) and "dirty" (STP) samples.

Where possible, composite samples should be collected by transferring individual subsamples (collected with a glass or stainless steel container to the same bottle that will be submitted to the laboratory. For example, a 8-hour composite sample should be comprised of eight (assuming hourly sampling)

sub samples of 125 ml each. The last sub sample should then fill the 1 liter sample bottle.

2.3 Sample Preservation

All samples bottles must be immediately refrigerated at 4 degrees C. in a darkened container (cooler, fridge). Exposure to light may cause deterioration of NDMA.

Samples should be transported to the lab as soon as possible (within 24 hours).

2.4 Trip Blanks

In order to establish field QA/QC, it will be necessary to include "trip blanks" in the initial surveys. Trip blanks are 1 L. amber glass sample bottles filled with distilled or tap water in which NDMA has not been previously detected. The purpose of the trip blanks is to expose the pristine water to all of the same conditions as the bottles containing the sample. The trip blank bottles are to be carried in the cooler and simply exposed to the ambient air during the sampling procedure at a predetermined sampling location. The trip blank is subsequently returned to the laboratory in the cooler for NDMA analysis. Should the analysis of the initial trip blank samples indicate that no significant changes have occurred, the use of trip blanks in further surveys may be discontinued.

2.5 General Precautions

There are a number of precautions of which the sampler should be aware:

- a) All contact of sample water with any rubber compounds should avoided (includes gloves, rubber stoppers, etc.). Gloves manufactured from PVC, cotton, and leather are acceptable substitutes for hand protection. Avoid any contact with the inner portion of the sample bottle and cap.
- b) Do not allow the sample bottle to contact the stream bottom or sides of a flow conduit (pipe, outfall, wet well etc.).
- c) No smoking during sampling. In addition, ensure that sampling takes place upwind of any obvious sources of combustion (e.g. car exhaust, power ice augers etc.).
- d) Ensure that a consistent bottle labelling protocol is followed. Label the bottle on site or double check the sampling location of a pre-labelled bottle.

R. Vickers

APPENDIX "L"

Excerpts from:

Morrison-Beatty Ltd.

Report on a Preliminary D-NAPL Investigation Former
Operating Pond Area, Uniroyal Chemical, Elmira,
October, 1989

REPORT ON
A PRELIMINARY D-NAPL INVESTIGATION
FORMER OPERATING POND AREA
UNIROYAL CHEMICAL, ELMIRA

morrison beatty



OCTOBER, 1989
PROJECT NO. 225-893

D.R. DUNCAN, C.E.T.
B.W. BEATTY, P.Eng.

4.0 RECOMMENDED D-NAPL INVESTIGATION

4.1 Purpose and Scope

The following program is recommended to evaluate the occurrence and significance of D-NAPL's under the former operating ponds, to determine the need for remedial work, and to develop a remedial program if necessary. The assessment will include the extent of D-NAPL's in both the water table aquifer and in the upper portion of the underlying till, estimates of D-NAPL quantities, and chemical characterization.

It should be noted that this D-NAPL investigation is separate from a post-remedial groundwater monitoring program following the pond clean out. However, some of the wells to be installed for this investigation may be useful for monitoring.

The D-NAPL investigation will focus on the area where D-NAPL's are most likely to occur, that is under RPW 5 and part of RPW 6. As such, the subsurface investigation will be carried out over the entire area of those two ponds, the surrounding berms, and the northern edge of pond RPW 7.

At present, all of these ponds are backfilled to ground surface. This is advantageous in terms of a test drilling program. The backfilled ponds provide a stable platform for drilling which should optimize geologic sampling and well installation.

4.2 Test Drilling

About 12 testholes will be drilled on a grid. Grid spacing will be about 25 m. The holes will be drilled using hollow-stemmed augers to allow collection of splitspoon samples from the ground surface to about 0.5 m into the underlying till. Splitspoon samples of the till will be examined to assess D-NAPL penetration into the till. When test drilling is complete, the holes will be plugged to about 0.15 m below the upper surface of the till.

In each testhole, a monitoring well will be installed. This will be socketed about 0.15 m into the till to provide a sump for the accumulation of D-NAPL's if present. A screen will be installed across the lower half of the water table aquifer. A continuous slot screen will be used which will be set into a sand pack. The primary purpose of the well will be to collect D-NAPL samples. In addition, the well will be used to monitor water levels and to collect groundwater samples.

The wells will be developed by bailing and low-rate pumping to maximize hydraulic efficiency. During the development, liquid samples will be accumulated from each well. These will be examined for the occurrence of separate phases.

In addition to the 12 proposed testholes, monitoring and extraction wells installed for the CH2M Hill project will be assessed to see if these will provide useful additional data for the D-NAPL investigation.

Geodetic elevations will be determined for each well (measuring point and ground surface elevations). This will permit topographic mapping of the aquitard surface as well as determining direction of groundwater flow.

4.3 Testing and Analysis

4.3.1 Hydraulic Testing

Slug tests will be performed on each well to determine the hydraulic conductivity of the water table aquifer in this area. In addition, in wells where D-NAPL's have been identified, pumpout/recovery tests will be performed to assess the rate of product accumulation. This will provide a means of assessing the extent of contamination as well as information on the hydraulic behaviour of D-NAPL's in this formation.

4.3.2 Laboratory Analyses

Samples of D-NAPL's collected from the test wells will be submitted to Uniroyal's Guelph laboratory for characterization.

4.4 Program Modifications

The results of this program may show the need for additional test drilling. This could include infilling within the grid or drilling outside of the initial grid to confirm the horizontal extent of D-NAPL's.

4.5 Reporting

A progress report on the initial results of the study will be completed within about one month after the completion of the drilling program. A final report, including laboratory results and a discussion of remedial measures will be prepared within six months of the completion of drilling.

4.6 Remedial Options

If D-NAPL occurrence is found to be significant in terms of a potential threat to groundwater quality, a remedial program will be developed. At present, we feel it is premature to draw any conclusions about what may be appropriate remedial measures. However, those that should be considered include:

1. Product removal by collector wells or horizontal drains.
2. Control of soluble-phase contaminant movement by means of wells or drains.
3. Excavation of contaminated materials.
4. *In situ* treatment methods.

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